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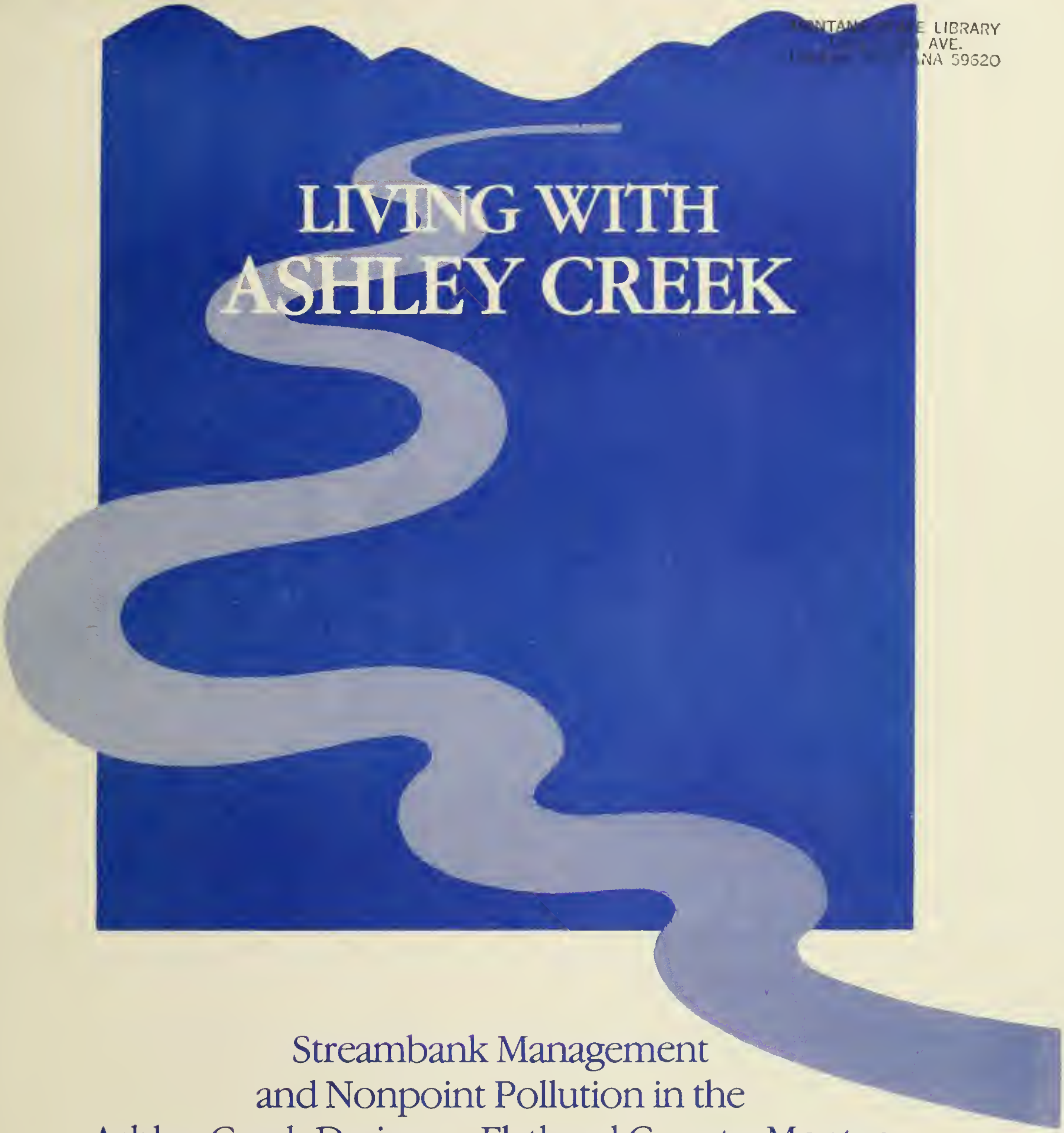

LIVING WITH ASHLEY CREEK

Streambank Management and Nonpoint Pollution in the Ashley Creek Drainage, Flathead County, Montana

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LIVING WITH
ASHLEY CREEK

Streambank Management and Nonpoint Pollution in the Ashley Creek Drainage, Flathead County, Montana

Barry Dutton, author
Beth Brennan, editor
Sue Spanke, illustrator

JANUARY 1987

PREPARED FOR: FLATHEAD CONSERVATION DISTRICT

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WITH ASSISTANCE FROM: MONTANA DEPARTMENT OF FISH, WILDLIFE, AND PARKS

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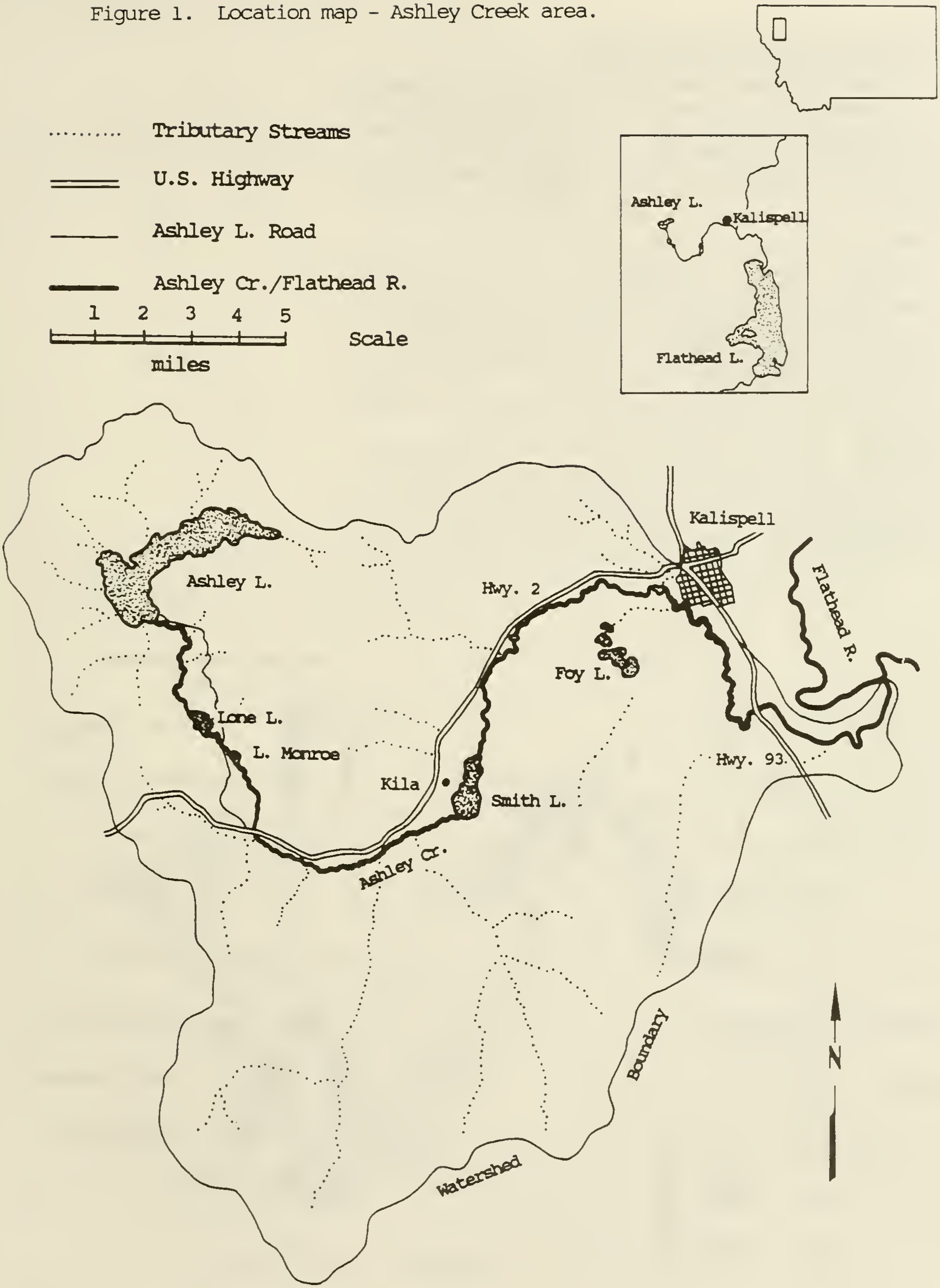
PREFACE

In June 1987, representatives from three natural resource agencies and the City of Kalispell conducted a streambank inventory of Ashley Creek. Information regarding streambank conditions was collected by walking or canoeing the entire length of the stream. This report summarizes the results of the inventory and provides an excellent picture of current streambank conditions. Sources of nonpoint pollution throughout the watershed are also reviewed and analyzed. This information is combined with water quality data to aid plans for a future of stable streambanks and clean water. Explanations of many technical terms are presented in the Glossary (Appendix 2).

Like most streams, Ashley Creek is affected by soil erosion, chemical runoff, sewage plant effluent and other pollutants. Individuals can contribute to the health of the creek by removing instream debris, planting vegetation, fencing livestock, and maintaining a healthy riparian corridor. Schools and organizations can contribute by "adopting" a streambank, and providing public education and opportunities for participation. Ashley Creek is a resource for many people in the Kalispell area. It deserves attention and improvement.

AERIAL VIEW LOOKING NORTH AT THE UPPER ASHLEY WATERSHED

Figure 1. Location map - Ashley Creek area.

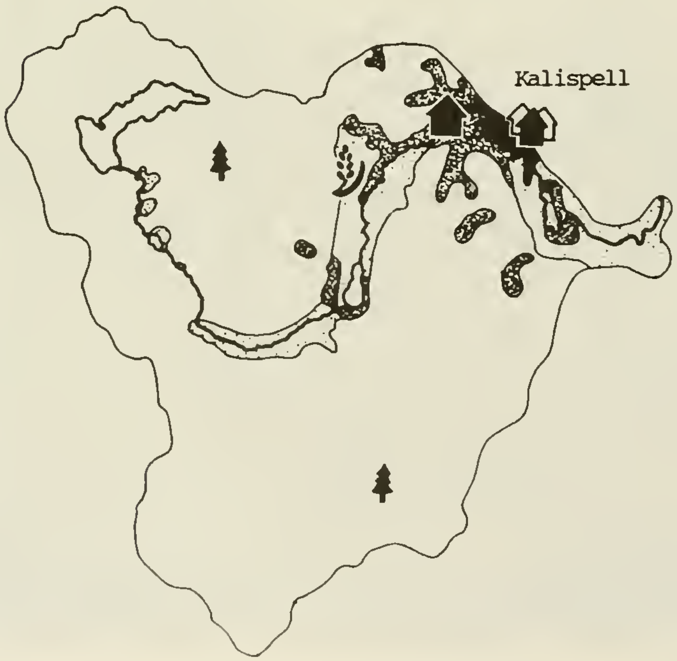


GENERAL INFORMATION

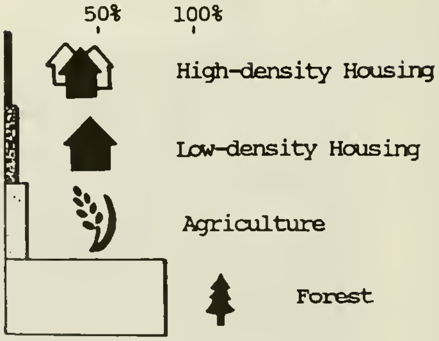
Ashley Creek was named for Joe Ashley. According to local legend, Joe was the first white settler of the upper Flathead Valley. The precise location of his homestead is uncertain, with several rumors placing it along the south side of the creek in the Foy Lake to Batavia vicinity. Joe was not content to stay in the valley, and in 1860 sold his property for $10 and moved on.

The Ashley Creek watershed covers about 180,000 acres, mostly in Flathead County, Montana (Figure 1). Ashley Creek begins at Ashley Lake and flows southeast, east, northeast and southeast again to join the Flathead River near Kalispell. Elevations in the watershed range from 2890 feet at the Flathead River to 6760 feet atop Blacktail Mountain. Annual rainfall ranges from about 14 inches in the valley bottom to over 30 inches at the upper elevations. Rainfall is spread quite evenly throughout the year except for June, which receives the most precipitation (over 2 inches in the valley).

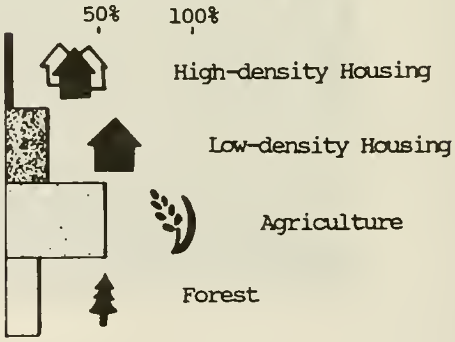
LAND USE



% Land Use-Ashley Watershed



% Land Use-Ashley Stream Banks

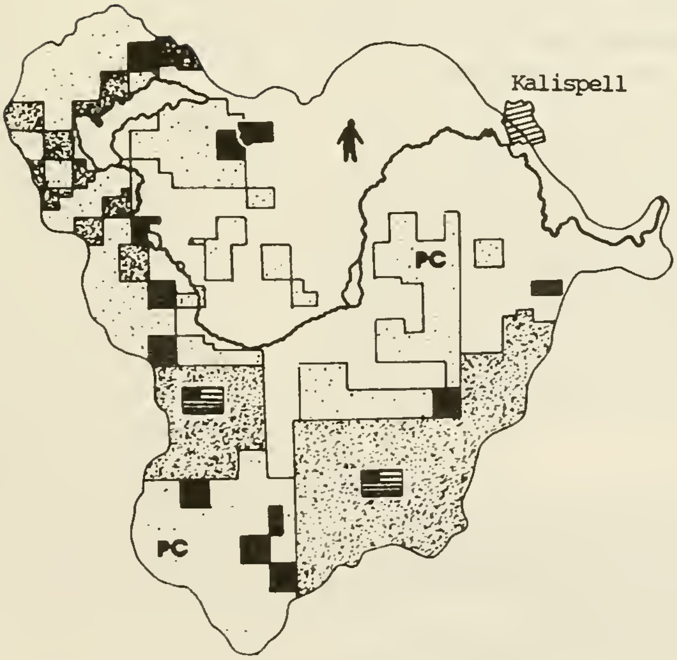


The upper Ashley watershed is dominated by coniferous forest vegetation and forest-related land uses, including timber harvest, recreation, and wildlife habitat. Two waterfowl production areas (Smith Lake and Batavia) are managed by the U.S. Fish & Wildlife Service for wildlife and recreational purposes.

Ranching and farming operations are scattered along the creek as it follows U.S. Highway 2 west from Kalispell. Agriculture is a common land use near the creek's confluence with the Flathead River. Private residences dominate the remainder of the watershed with the density increasing closer to Kalispell. Ashley Creek flows through the southwest corner of the Kalispell city limits.

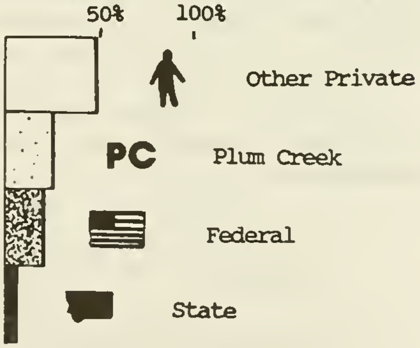
Approximately seventy-five percent of the Ashley Creek watershed is privately owned. A third of this private land is owned by a single timber company (Plum Creek Timber). Over ninety percent of the land along the immediate streambanks is privately owned. Only a few percent of these streamside private properties are owned by Plum Creek Timber.

LAND OWNERSHIP



(approximate-major holdings only)

% Ownership - Ashley Watershed



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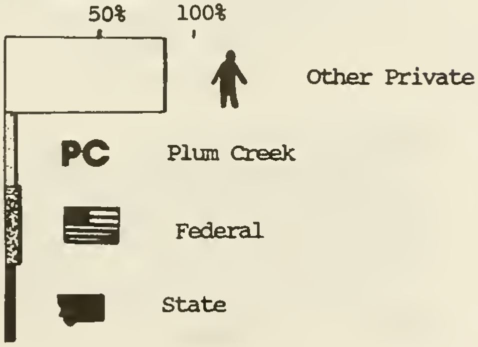


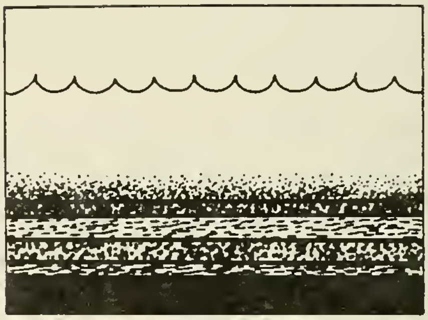
HISTORY: How the Land was Formed

Geologic History

The Ashley Creek watershed has a long and exciting geologic history. The area was first a shallow sea, then a desert, and later the playground of glaciers and glacial lakes. Ashley Creek was pushed around the landscape by these events, at times flowing high above the current valley, at other times flowing within the glaciers themselves. Only in the last ten thousand years has the creek settled into its current drainage pattern.

Ancient Sea

Around a billion years ago, this part of western Montana was a shallow sea. Streams carried thousands of feet of sediment into this sea from surrounding lands. Pressure from above and heat from below hardened this sediment into the quartzite (hard sandstone), argillite (hard mudstone) and limestone rocks which dominate northwestern Montana today. Bedrock under most of the Ashley Creek watershed is dominated by limestone and calcareous argillite of the Siyeh formation. East of Batavia, the bedrock is dominated by limestone of the Piegan formation. Ravalli Formation argillites occur in the western and southwestern portions of the watershed. These rock formations are by no means pure limestone or pure argillite, but contain layers of other rock types.



ANCIENT SEAFLOOR DEPOSITS

Some characteristics of these rocks which influence current watershed use and streambank management include:

1) They break down into soils with silty textures

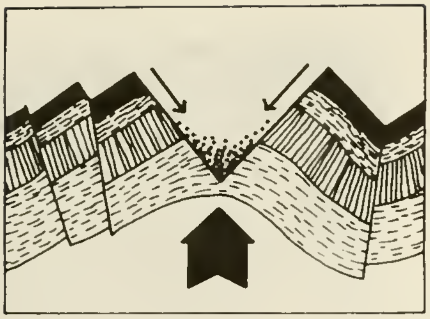
2) They are calcareous, which will buffer the effects of acidifying influences such as acid rain.

3) Their permeability and water yield are often quite low.

Uplift and Erosion

About 150 million years ago the Rocky Mountains began to be uplifted. Widespread faulting broke up the old sedimentary rocks and our current mountain and valley landscape began to take shape.

From about 40 million years ago until the Ice Age began 3 million years ago, a dry, desert-like



UPLIFT AND EROSION

climate dominated western Montana. In this climate, few plants grew to protect the soil from erosion. As the mountains were uplifted, they were simultaneously eroded. Much of this erosion occurred during infrequent, intense, "gully-washer" rainstorms which carried soil and rock materials into the valleys. No permanent streams or rivers existed to carry these sediments to the ocean, so most western Montana valleys filled with thousands of feet of sediments in the Tertiary period.

Mixed in with these stream deposits are discontinuous layers of volcanic ash and lake sediments with few or no rocks. Some volcanic ash may have come from the Hogs Heaven eruptions just west of Flathead Lake.

The current distribution of Tertiary-age sediments has not been well documented in the Kalispell area. Beneath portions of the main valley area near Kalispell, these sediments may be hundreds of feet thick. They are overlain by dozens to hundreds of feet of more recent materials, especially glacial till and stream deposits. The thickness of these sediments and their overburden varies considerably. Tertiary deposits have been completely removed from most of the upper drainage (west of Kalispell) and some valley-bottom sites. These sites usually have relatively shallow bedrock (<200 ft). Tertiary sediments are a heterogeneous mixture of materials often containing abundant clay and silt with varying amounts of rock. Layers of sand and gravel do occur but are less common and usually discontinuous.

In the Ashley Creek watershed, undisturbed Tertiary deposits are not currently exposed at the land surface but have been removed or reworked by later events. Some local glacial deposits inherited characteristics of the tertiary deposits they are composed of (clay texture and bright colors, especially red). Some non-bedrock wells in the lower valley area extract their water from Tertiary sediments.

Significant implications of Tertiary deposits for land use management include:

1) They can be highly variable over short horizontal and vertical distances

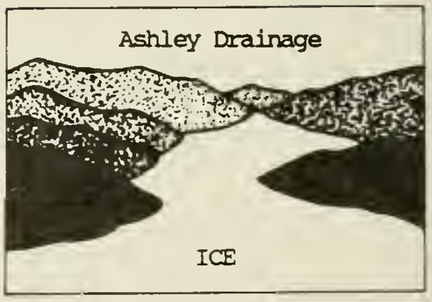
in texture, rock content and many other important properties. Site investigations for construction must be very specific in order to reveal the true characteristics and variation across the project area. Homes on adjacent lots may be only 50 feet apart but with completely different soil characteristics.

2) They are dominated by silty and clayey soils with moderate to slow permeabilities. Slow permeabilities can be a problem if drainfield effluent cannot enter the soil quickly enough. Slow permeabilities can be beneficial in preventing vertical or horizontal migration of drainfield wastes, hazardous waste spills, and other harmful substances into aquifers, lakes and streams.

3) Many of these deposits are calcareous (have abundant calcium carbonate), which buffers the effects of acidifying influences such as acid rain.

The Ice Age

Approximately 3 million years ago the climate became slightly cooler and much wetter. Though we call it "the" Ice Age, there were actually at least two or three major periods of glaciation. During each of these major periods, local glaciers advanced and retreated many times. Throughout the Ice Age, our former Tertiary landscape was severely eroded by ice, wind and water. Streams developed, flowing out of each drainage and joining to form local river systems carrying Tertiary sediments to the ocean. Hundreds of feet of Tertiary sediment were removed from western Montana valleys at this time. Glaciers bulldozed and reworked the upper layers of this new landscape. Winds separated glacial sands from other materials and transported them across the surface of this landscape as dunes.



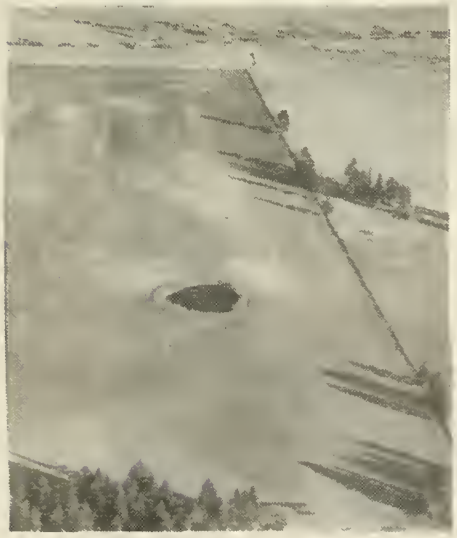
A lobe of the continental ice sheet flowed south down the Rocky Mountain trench (Flathead Valley) almost to St. Ignatius. This ice mass pushed westward up the current Ashley Creek (Smith) valley, and was at least 2500 feet thick near Kalispell. Ice also moved southward along the western border of the Ashley Creek watershed near Little Bitterroot Lake.

As ice advanced and retreated across the present drainage area it radically changed the flow of Ashley Creek. At times the ice pushed Ashley Creek up onto the mountains south of its present course. At other times, water from the Ashley watershed flowed southeast through the "gap" now occupied by Foy Lake. This southern flow of water was trapped between the valley glacier on the east and the mountains on the west, carving notches in the bedrock at many different elevations. At one time, this water flowed over a thousand feet above the current Flathead Lake level. It wound around the west side of Lake Mary Ronan, across the face of Chief Cliff, before turning southwest into the Hot Springs valley (Figure 2).

2 INCH DEEP GROOVES CARVED INTO BEDROCK BY GLACIERS (HWY 2 TURNOUT TWO MILES E OF THE ASHLEY LAKE RD)

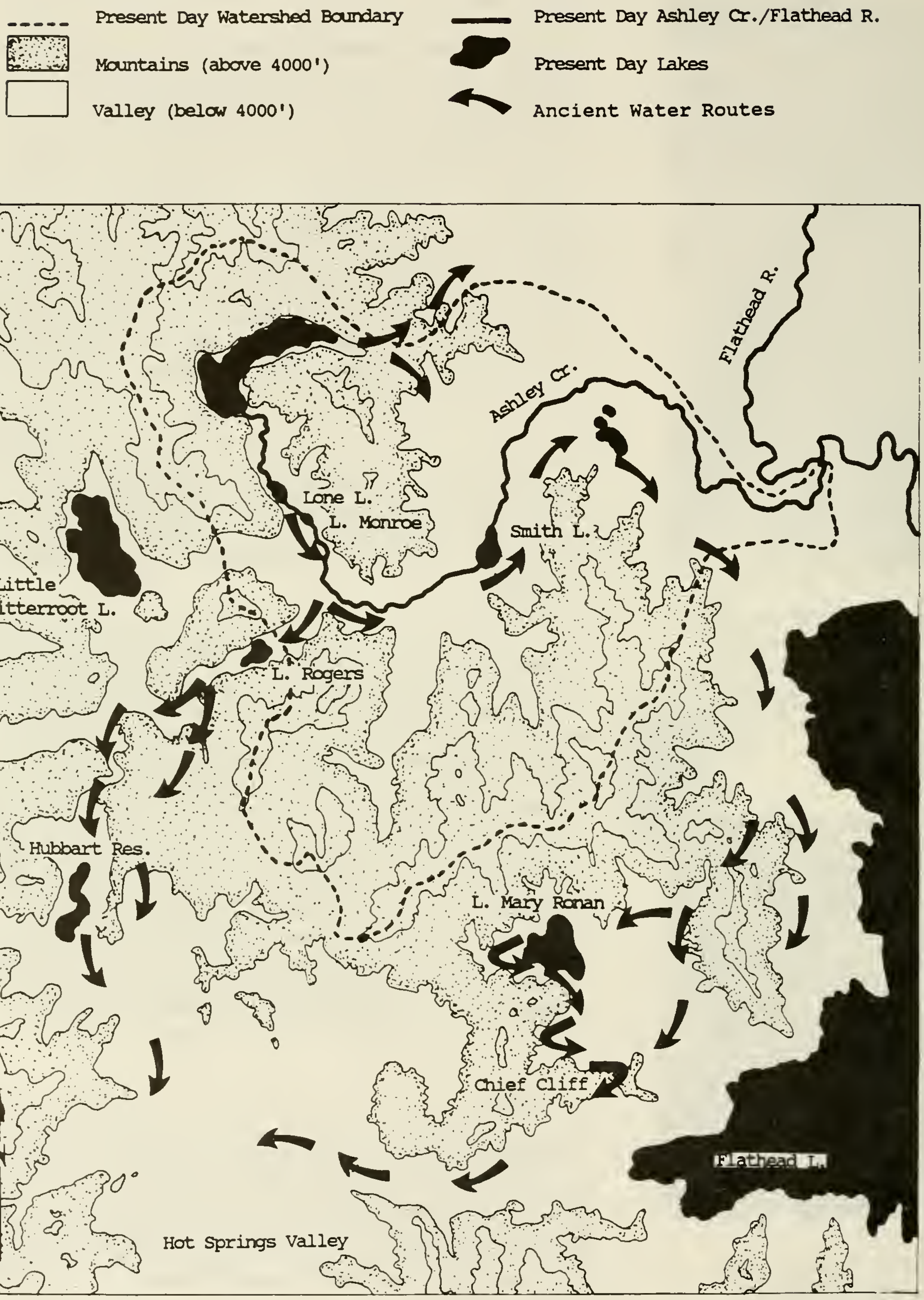
At other times, ice blocked all easterly flow from the upper Ashley drainage and meltwaters from the drainage were forced southwest through several narrow passes to join the Little Bitterroot River. It is also likely that water sometimes flowed into the upper Ashley Creek watershed from the northeast.

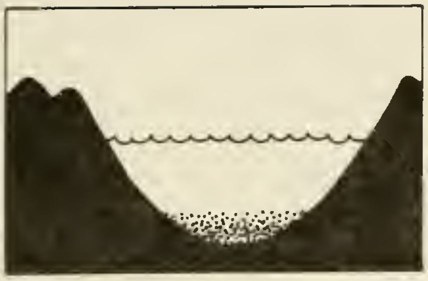
The modern flow pattern of Ashley Creek was determined as the Ice Age ended. During the final retreat, glacial till was piled on the valley floor in the upper drainage. This till acted like an earth dam, impounding water and creating Ashley Lake. When the glaciers retreated, large ice blocks dotted the landscape. The largest blocks melted to form Smith, Lone, Monroe and other lakes. Smaller ice chunks became ponds and depressions. Some of these ponds still exist while others have been filled with organic deposits and mineral sediments. The formation of Foy Lake and some other area lakes began as a combination of faulting and uplift to leave a depression in the landscape capable of holding water. Glacial ice further scoured these sites and left earthen "dams" or moraines which further helped impound water.


POTHOLE LAKE WEST OF KALISPELL

In addition to stream activities, glacial lakes were also common. When glaciers pushed up Ashley Creek they initially acted as ice dams, creating large lakes in the upper drainage. These lakes would fill until the waters found an escape route. At times this route may have been to the southeast, into the Flathead Valley. During other periods, this escape route was to the southwest. Some of

Figure 2. Routes of water draining the Ashley watershed area during the last ice age.





GLACIAL LAKE DEPOSITS

these lake drainings were probably catastrophic events involving large volumes of water. Water from the Ashley Creek drainage area was probably one factor which helped form the Little Bitterroot canyon.

These events of glacial advance, lake formation, stream alteration, glacial retreat, pothole lake formation and organic matter accumulation happened many times throughout the Ice Age. The result is a complex layering of mineral and organic deposits in the lower drainage. In the upper drainage, glacial ice left the limestone mountains semi-rounded. Glacial till blankets these mountain slopes in highly variable thicknesses. At some sites, the ice scoured completely down to bedrock and left no till.

Some implications of Ice Age deposits for land use and management include:

1) They can be highly variable over short horizontal and vertical distances in texture, rock content and many other important features. Site investigations for construction must be very specific in order to reveal the true characteristics and variation across the project area. One home may be on one soil type and the next on very different material.

2) They are dominated by soils with silty textures and moderate to slow permeabilities. Slow permeabilities can be a problem if drainfield effluent cannot enter the soil quickly enough. Slow permeabilities can be a benefit by preventing vertical or horizontal migration of drainfield wastes and other harmful substances.

3) These deposits contain sandy or gravelly layers with very rapid permeabilities. Rapid permeability is a problem because it doesn't provide for adequate "treatment" of sewage wastes from drainfields. Rapid permeability may also allow effluent or other pollutants to move into and through the soil, quickly polluting aquifers, wells, and surface waters.

4) Most of these deposits are calcareous, which buffers the effects of acidifying influences such as acid rain.

5) These deposits contain organic matter accumulations from small glacial depressions or large lakes. These deposits may have dramatic effects on water quality, as with the color and sulfur content near Smith Lake. Construction requires special techniques on organic soils.

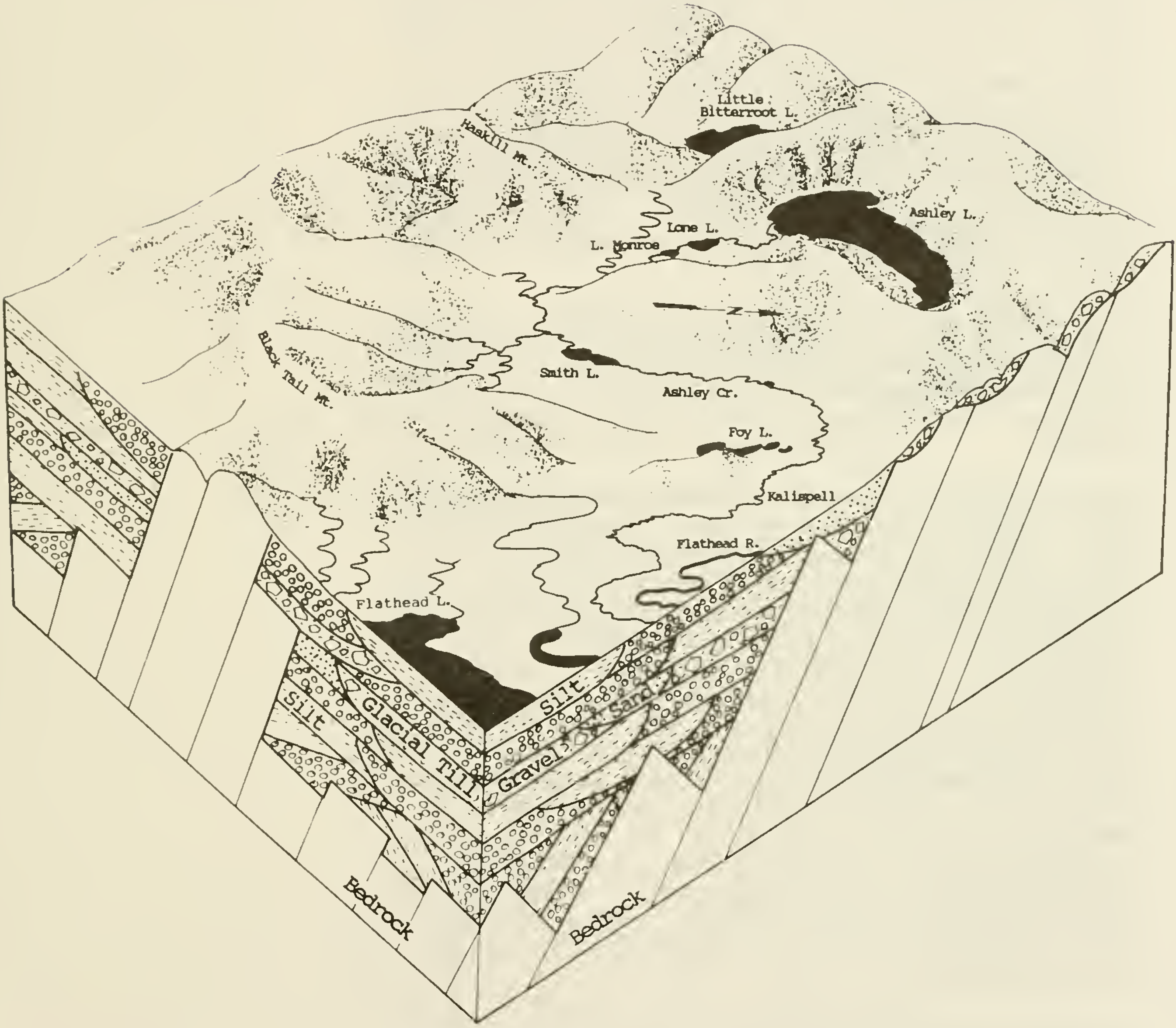
Recent Times

After the last glacier retreated, streams such as Ashley Creek settled into their current drainage patterns. These streams carried sediments and began filling in many small ponds and lakes. Ashley, Smith and other lakes have been dramatically reduced in size by this process.

While streams put the finishing touches on our present landscape, west coast volcanoes added ash to the surface of Ashley watershed soils. Mount Mazama (Crater Lake, Oregon) erupted 6600 years ago and deposited the most volcanic ash. Soils in the Ashley Creek watershed have up to eight inches of ash in the surface layer, primarily from this one eruption. The ash is easily recognized by its bright reddish brown color, which usually appears much different than the soil below. Mount St. Helens, Glacier Peak and other west coast volcanoes have added smaller amounts of ash.

This long and eventful geologic history has left a landscape of challenge as well as beauty. Some important results of this history include the variability of soil materials, the dominance of silty and calcareous soils and the occasional presence of sandy, highly permeable soils. Figure 3 illustrates a three-dimensional view of the current watershed area.

Figure 3. Simplified block diagram of the Ashley Creek Area (vertical scale is exaggerated)



Ashley Creek Soils

Soil is one of our most valuable resources. It supports structures, produces crops, disposes of wastes and performs many other essential services.

Soil texture is often referred to as the single most important soil property. Classifications of soil texture date back 4000 years to the ancient Chinese. Soil texture is determined by the particle size distribution (percentage of rocks, sand, silt and clay). The USDA Soil Classification System identifies "rocks" as mineral particles over two millimeters (mm) in diameter and are subdivided into gravel (2mm to 3in dia), cobbles (3in to 6in), stones (6in to 24 in) and boulders (>24in). Rocky soils have low nutrient and water retention capacities and rapid permeabilities. Rocks are carried in streams as bedload (bounced along the bottom), not suspended as sediment. Rocks often provide a stable bottom or "armor" on the streambed and create ideal spawning sites for fish.

Rocky soils may provide a stable base for construction, but excavation can be difficult and expensive. Waste disposal systems may not function adequately because of insufficient soil to "treat" the effluent and rapid migration of wastes.

Sand is between 2 mm and .04 mm in diameter and will settle out of still water in 40 seconds or less. Sandy soils have the same low nutrient and water retention capacities as rocky soils. They also have rapid permeabilities which allow fast migration of drainfield effluent or other pollutants. Individual sand particles do not bind together into "clods" as do clay particles. They may often occur as individual grains. Sand grains are easily dislodged and transported by water or wind. When water moves slowly, sand is transported as bedload. When water velocity is more rapid, sand is transported as suspended sediment. Wind transports sand particles by bouncing them along the ground, eventually forming dunes. Sand is often deposited along with gravel and cobbles by running water. Sandy soils usually do not support steep streambanks.

Extremely sandy soils require special construction techniques to overcome the looseness of the material and its tendency to "melt" away. These soils also have rapid permeabilities and may not provide adequate treatment for drainfield effluent.

Silt particles are between .04 and .002 mm in diameter and will take 40 seconds to 2 hours to settle out of still water. Silty soils have as much as 10 times the nutrient and water holding capacity of sandy soils. They have relatively slow permeabilities, although large drainfields usually function well. Some silty soils have very slow permeabilities due to post-deposition weathering, compaction by glacial ice, the means of deposition or other mechanisms. The restricted permeability of silty soils is beneficial in slowing the migration of pollutants.

Slightly smaller than sand, silt can easily be carried in suspension by moving water. Silt is deposited where moving water slows significantly or empties into a calm water body (lake or pond). Most lake deposits are therefore dominated by silt. Silt can be deposited along the slower reaches of streams or across the entire floodplain during floods.

Silt is also the most common size of particle transported by wind. The ash which has reached Montana from west coast volcanoes is predominantly silt-sized. Heavier, sand-sized ash particles are deposited much closer to the source.

Clay particles are less than .002 mm in diameter and take more than 2 hours to settle out of still water. Clay has a very high nutrient retention capacity. Clay also has a very high water holding capacity, but it "holds" the water so tightly it is difficult to extract. Clay particles are the "glue" which hold sand and silt together in most soils. Clay soils have very slow permeabilities and do not function well for septic tank drainfields. These soils ususally provide insufficient support for structures, roads and other projects without the use of special construction techniques.

Clay is not easily eroded from banks since it binds tightly together into distinct "clods" which are difficult to dislodge, transport and dissolve. Streambanks through clay soil areas are often nearly vertical, with mass wasting as the major form of streambank erosion. When clay is transported by streams it is usually carried in suspension. Clay is deposited in large bodies of still water such as large lakes. Clay forms from other minerals, especially volcanic ash. It forms slowly and is most common in older geologic materials such as Tertiary deposits.

Clay soils are not often eroded by wind because the individual particles bind together into clods too large to be carried. In some exceptional cases however, these clods may be silt-sized or sand-sized and very easily transported by wind.

Soil is formed in relation to five main factors:

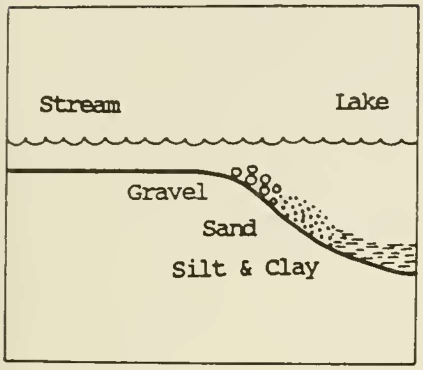
Parent Material (what the soil formed from, its geologic history)
Climate (temperature and precipitation)
Topography (slope steepness and aspect)
Organisms (plants and animals add organic matter and have other influences)
Time (how long the soil has been forming)

Parent material is usually the most important of these factors in western Montana due to our exciting geologic past. By understanding and remembering the type of deposit left by each major geologic process, you can recognize the major types of soil parent material while you are out in the field.

Wind usually leaves deposits that have very uniform silt textures and no rocks. Silt may be carried on the wind for long distances. Wind may also deposit and redistribute sand-textured deposits, but these must have a local source such as glacial outwash or sandy lakeshores. Wind deposits (aeolian or loess deposits) are recognized by their uniform silty or sandy, rock-free texture, and sometimes by their dune appearance.

Running water sorts materials into relatively uniform particle sizes and smooths the edges of rocks into spheres. The size of material which can be carried depends on the volume and velocity of the stream. Most streams and small rivers carry sand and gravel sized materials with occasional cobbles and stones. Large rivers and glacial outwash streams carry cobbles, gravels, sand and some stones. These deposits are recognized by the uniform size of very well-rounded rocks in each layer. Multiple layers of different size materials may be deposited on top of one another with sands and gravels alternating.

STREAM DROPPING SEDIMENT IN A LAKE



Lakes, ponds and other still water bodies also sort materials into different size classes. When streams carrying sediments reach a lake, the reduced velocity allows sediments to be deposited. The rocks are dumped immediately and together with most of the sand form a "delta" out into the lake. The silt and clay settle out more slowly in the deeper water. Only the largest lakes in western Montana have been big enough to allow the deposition of relatively pure clay. Lake and pond deposits may in some cases have abundant organic matter accumulations such as those around Smith Lake. Lake deposits are usually recognized by their rock-free silty or clayey texture.

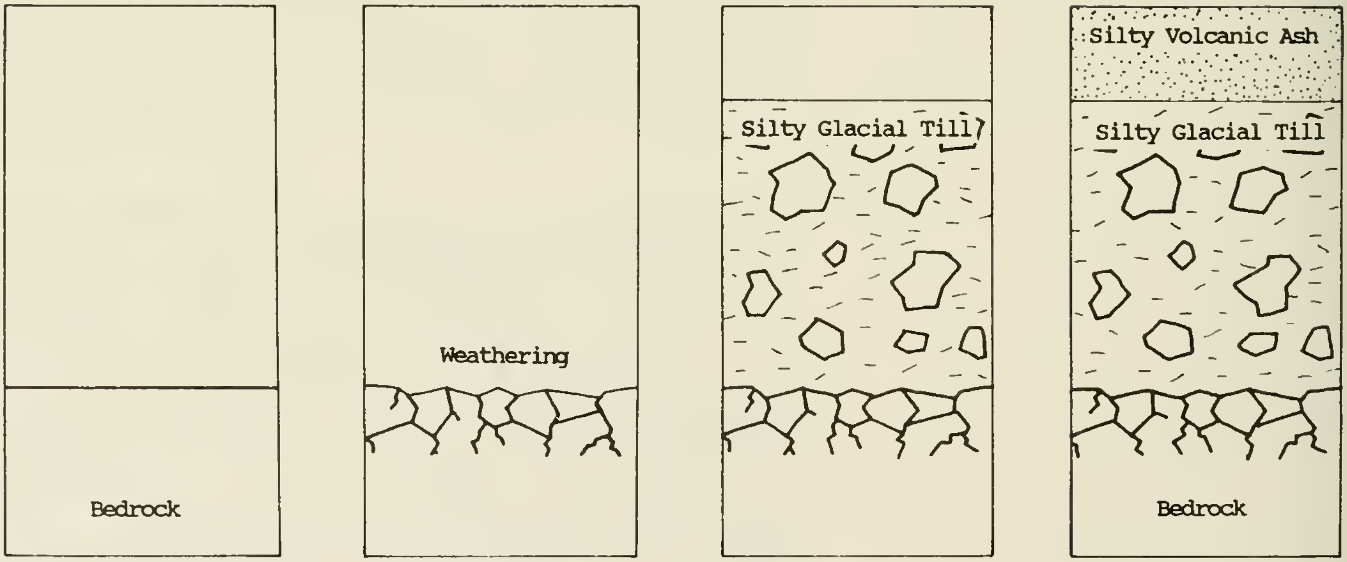
Glaciers do not sort materials by size but instead mix sand, silt, clay, gravel, cobble, stones and occaional boulders into a heterogeneous mixture without apparent order. The rocks are usually semi-rounded by this process and may be very contrasting. Glacial till can be recognized by the presence of various sizes, shapes and compositions of rocks in variable amounts imbedded in a matrix of finer soil materials.

For the purposes of this brief discussion, the Ashley watershed soils can be divided into two groups: the mountain soils which are on the steeper slopes, mainly above 3400 ft. elevation, and the valley soils below (Figure 4).

The mountain soils of Ashley creek are underlain by limestone bedrock, or in limited areas, argillite and quartzite bedrock. Bedrock is exposed at the surface in small areas, but is usually overlain by weathered materials of various origins. Soils with shallow bedrock are important because they pose problems for construction, waste disposal, and other land uses.

Across most of the drainage, the bedrock is fractured and weathered with a rocky layer of soil material overlying it, which weathered from the bedrock.

Since most of the drainage was covered by glacial ice, a layer of glacial till occurs across most of these mountain landscapes. This glacial till is usually 5 to 50 feet thick but may be thicker at some sites. This till is usually silty and calcareous. The high silt content makes these soils easily eroded by wind and water.



SEQUENCE OF DEVELOPMENT FOR ASHLEY WATERSHED MOUNTAIN SOILS

Most mountain soils have a surface layer of volcanic ash up to eight inches thick, which is most evident and thickest on northerly aspects. There are several possible reasons for thicker ash on north slopes. Winds may deposit ash on northerly aspects in greater amounts than southerly aspects. If the ash fall occurred when snow was still on north aspects but not south, more of the ash would remain on those north slopes since ash "sticks" to snow. Vegetation may have been much denser on north aspects at the time of deposition, preventing erosion by wind and water and allowing the ash to remain on north slopes. These scenarios are theoretical and the true reasons are yet to be determined.

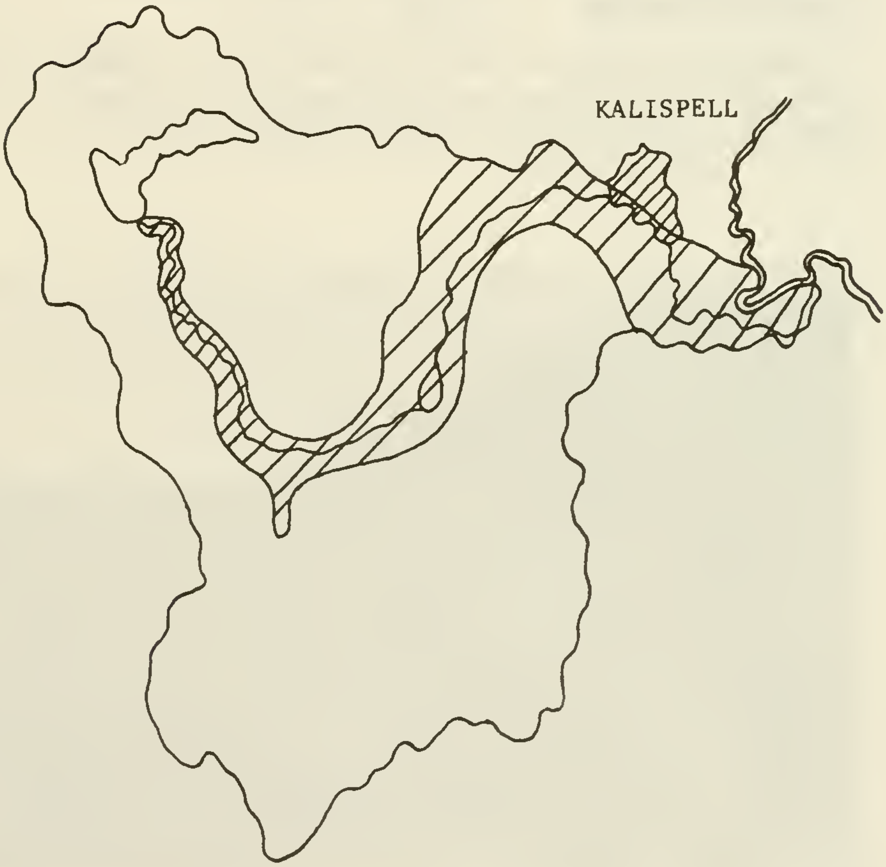


Figure 4. Generalized distribution of Mountain and Valley soils.

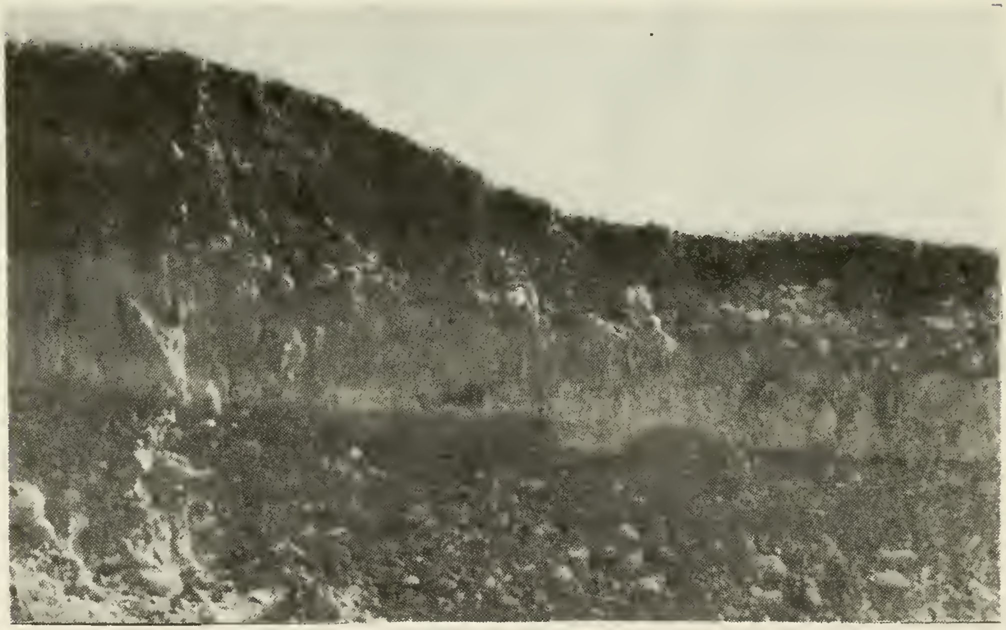
The valley soils of Ashley Creek are underlain mostly by limestone bedrock but at greater depths than the mountain soils, usually over 200 feet and in spots over 500 feet.

Tertiary deposits may overlie the bedrock in some portions of the lower Ashley drainage but were buried or disturbed by more recent activities and deposits.

Most valley surface soils are formed in glacial till and glacial lake deposits. These soils are silty, calcareous and have relatively slow permeabilities. They are easily eroded by wind and water.

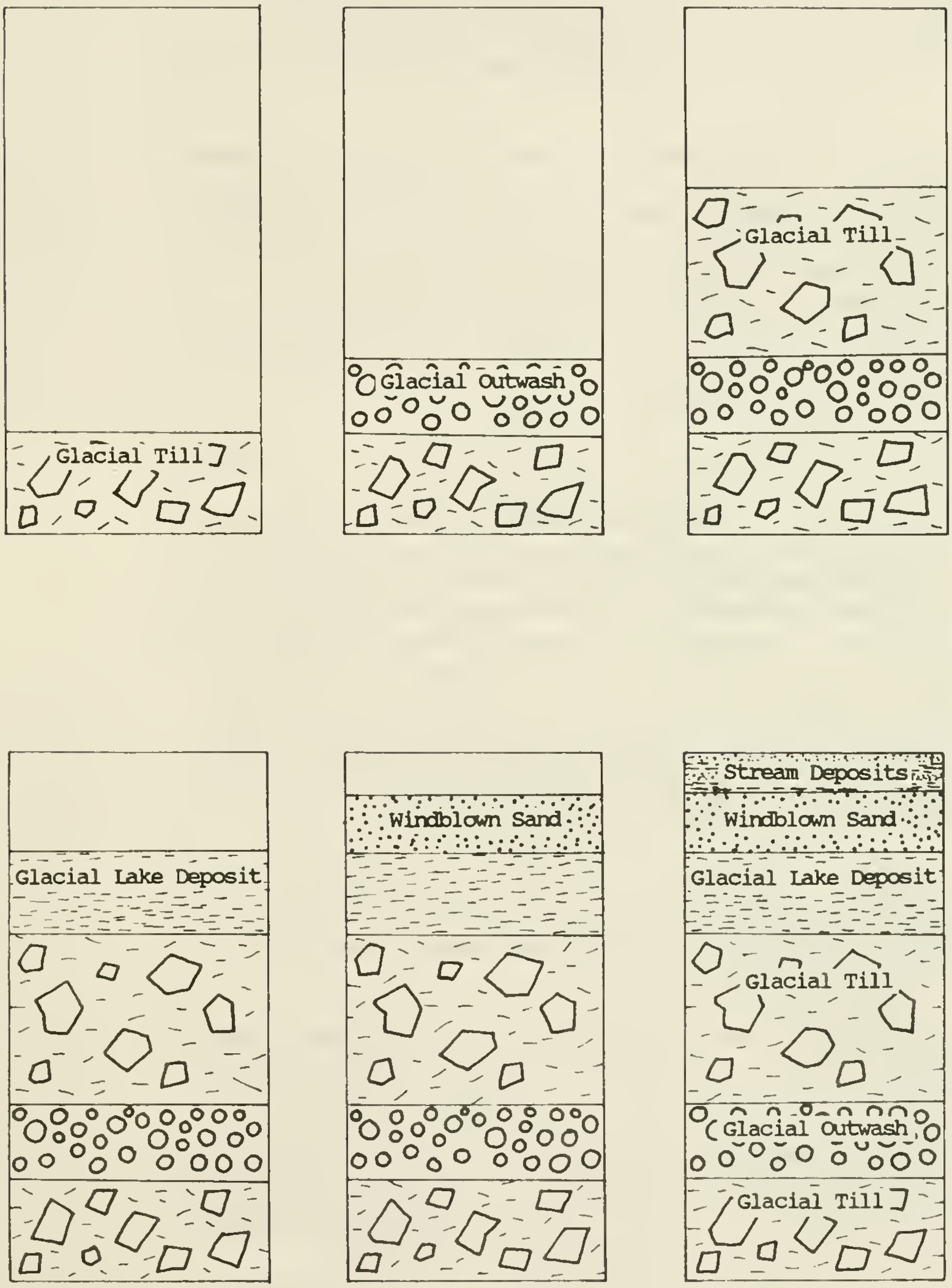
Intermixed with these glacial till and glacial lake soils are areas with glacial outwash and more recent stream deposits. These soils are very rocky, sandy and porous. They occur across small, isolated areas and many have been used as sources of sand and gravel.

A few small areas of valley soils have a surface layer of wind-blown sand. This sand probably was blown from sandy glacial outwash deposits soon after the ice retreated.



EXAMPLE VALLEY SOIL PROFILE
(CEMETERY ROAD GRAVEL PIT)

SEQUENCE OF DEVELOPMENT FOR ASHLEY WATERSHED VALLEY SOILS



Two important characteristics of most Ashley watershed soils are their alkaline pH and their silty texture, both of which are influenced by the limestone bedrock, glacial till and glacial lake deposits. Silt increases the soil's ability to absorb nutrients supplied by septic tank drainfields, agricultural fertilization or other means. This high silt content also reduces permeability and slows movement of septic tank effluent, hazardous waste and other pollutants. These factors help prevent widespread pollution of local aquifers.

The high silt content of Ashley Creek soils makes them very erodible. Silt is the particle size most commonly carried by moving water, and the abundance of silt in local soils provides an endless supply of sediment. Silt particles are smaller than individual sand grains and don't bind together into large aggregates like clay does. This problem becomes acute wherever soil surfaces or streambanks are exposed to erosion.

Although most Ashley Creek soils are silty, some sites have very sandy soils with rapid permeability. Some sandy soils are stream deposits and contain both sand and gravel, while others are windblown sand dunes with no rocks. Sandy soils are easy to locate in the Kalispell area because they favor the growth of trees instead of grass and often support "islands" of ponderosa pine. Septic tank drainfield effluent and other pollutants can migrate quickly through these soils to reach ground or surface waters. Waste disposal systems installed in these soils should be monitored for their effect on water quality.

Another significant characteristic of many Ashley Creek soils is their low organic matter content, especially in the subsurface layers where drainfield effluent is released.

Soils along the riparian corridor of Ashley Creek deserve special mention. These soils are highly variable, ranging from pure silt and clay to pure sand to sand and gravel to mixtures of all these textures. Soils in this zone can change quickly from one texture to another, and it is important to recognize these differences when planning projects. Bank stabilization, revegetation, and other activities must be soil-specific to be successful. Most soils along the Ashley Creek riparian corridor have gravelly sandy loam or gravelly silt loam textures. These soils are easily eroded by water. On some of the flatter land surfaces where the stream meanders most, the soil is dominated by silts and clays with few rocks. These sites often have the steepest banks since silt and clay hold the soil together and can stand at a steeper angle than sandy or gravelly soils.

Organic soils occur near Smith Lake and in small areas elsewhere along the corridor. These soils contrast sharply with mineral soils due to their low strength and high acidity. Organic soils require special management and should be treated with caution. The soils of the Ashley Creek riparian corridor should be properly managed to protect water quality and other values.

Soil surveys covering the lower Ashley Creek watershed were published in 1919 and 1960 by the USDA Soil Conservation Service. These projects occurred when agriculture was emphasized as the major user of soil information. Soils were grouped into series with "modal" or "average" characteristics which often portray surface features very well. However, these reports did not discuss the horizontal and vertical variability of local soils, their origin, parent material, or potential for other common land uses. In 1970, the Soil Conservation Service distributed a supplement to the 1960 report which discussed the use of area soils for engineering and development purposes. This supplement was revised and reprinted in 1982 by the Flathead Conservation District.

This soil survey information is useful for certain purposes such as locating general areas with highly permeable soils. The soils identified in the 1960 report which have very sandy textures and rapid permeability include: Alluvial Lands, Blanchard, Flathead, Tally and Yeoman soils. Small areas of highly permeable soils can also be found outside these delineations. It is important to identify these soils since they require special construction techniques, are susceptible to wind erosion, and may allow rapid migration of sewage effluent or other pollutants.

Soil information for Forest Service Lands in the Ashley Creek watershed is available in the landtype inventory of the Flathead National Forest (Martinsen and Basko 1983).

As with all natural resources, care must be taken to protect soil for continued productivity and future use.

Ashley Creek: A Profile

No two streams are exactly alike. Each is affected by climate, topography, geologic and soils materials, stream gradient (steepness), vegetation and other factors. Ashley Creek is a very unusual stream for many reasons. One of the most important is the strong influence of the post-glacial topography on stream characteristics, including gradient and meander frequency. We usually think of streams as shaping the landscape, but in the case of Ashley Creek the landscape has shaped the stream. Where glaciers left nearly level till deposits, the stream runs slowly and meanders constantly. Where glacial ice scoured steep grades or down to bedrock, the stream runs straight and fast. Near its confluence with the Flathead River, Ashley Creek has been "captured" by one of the river's abandoned meander channels in which the creek now flows. Some of Ashley Creek's other distinguishing features include:

1) Tremendous variation in gradient and materials.

2) A series of lakes along its course which act as sediment basins to reduce sediment levels, and flood control structures to reduce flood severity.

3) Large amounts of organic matter and organic soils along its course.

4) Severe water quality problems from both natural and cultural sources, especially the Kalispell sewage treatment plant.

5) The presence of a rare aquatic insect in the Helicopsyche genus of the caddis group (pers. comm. Jack Stanford).

Ashley Creek flows from its lake source across a relatively flat glacial moraine surface containing Lone Lake and Lake Monroe. The gradient is slight, the materials silty and the stream has many meanders. Where the gradient steepens near the falls, the creek takes a much more direct path with few meanders. Below the falls the gradient flattens out once again and the stream has a moderate amount of meanders until it reaches Kalispell.

From the Foy Lake road (west of Kalispell) to Snowline Lane (southeast of Kalispell), Ashley

AERIAL VIEW LOOKING NORTH AT THE UPPER ASHLEY WATERSHED

ASHLEY CREEK CROSSING AT HWY 2 NEAR ASHLEY LAKE ROAD

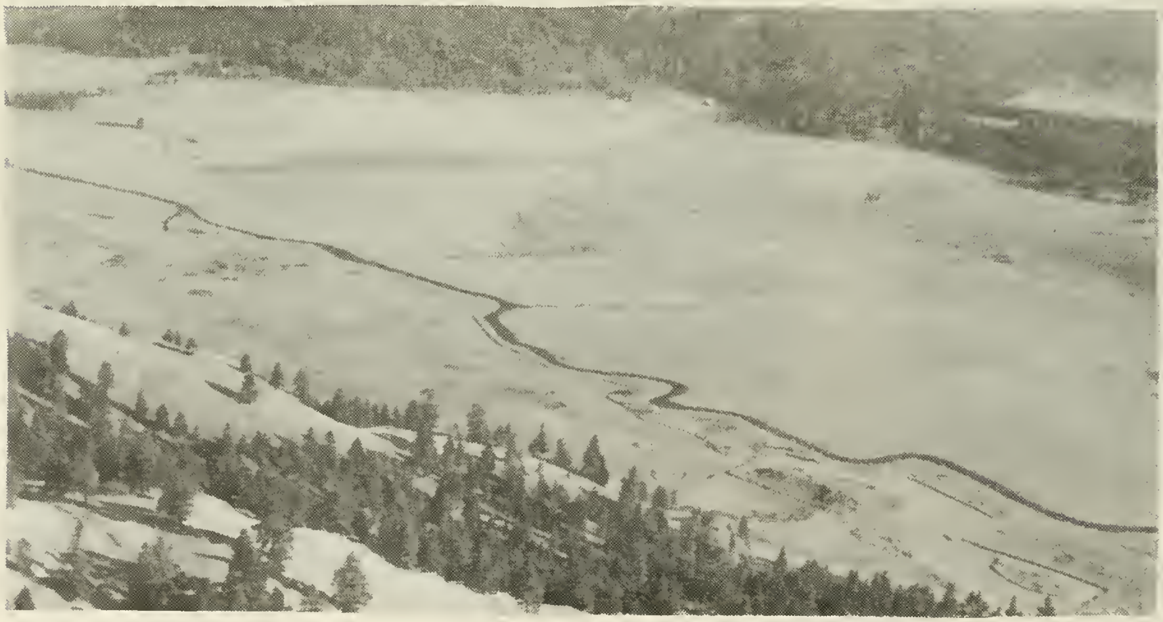
ASHLEY CREEK SOUTH OF ASHLEY LAKE

ASHLEY CREEK WEST OF KILA

Creek crosses a very flat, very silty land surface. In this section, the stream undergoes its most dramatic meandering. East from Snowline Lane, the creek flows along old channels of the Flathead River and resembles a bayou slough with very little meandering.

Each section of Ashley Creek has unique properties which must be considered for planning projects. Each section is dynamically related to the landscape and soils across which it flows.

ASHLEY CREEK AT SNOWLINE LANE



ASHLEY CREEK WEST OF SMITH LAKE

AERIAL VIEW LOOKING UP THE DRAINAGE FROM KALISPELL

ASHLEY CREEK AT ITS CONFLUENCE WITH THE FLATHEAD RIVER

Ashley Creek Vegetation Before White Settlement

There has been a great deal of interest in reconstructing Montana's vegetation before the white man settled here. While some details are uncertain, enough information exists to be confident about the general appearance of early plant communities.

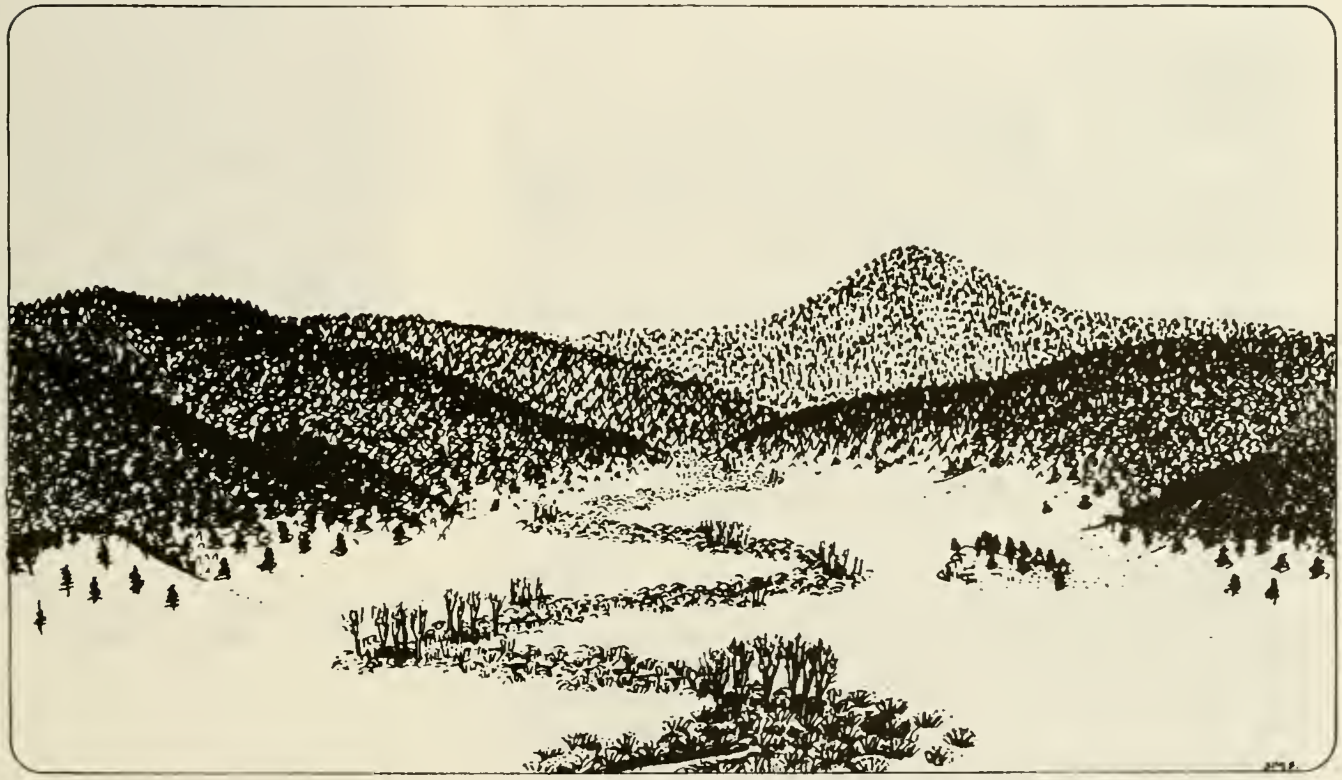
The upper Ashley Creek watershed has been forested for centuries. It appears today much as it did when Joe Ashley first saw it over one hundred years ago. The lower drainage area and creek bottoms, however, have experienced radical alteration of their vegetation. Like most riparian areas in western Montana, Ashley Creek was previously lined with extensive, dense growth of shrubs, including red-stemmed dogwood, hawthorn and several species of willow. Black cottonwood, narrow-leaf cottonwood, paper birch, and water birch were common riparian trees. A few conifer trees such as Ponderosa pine, Douglas fir, and Englemann spruce were also scattered along the riparian bottom.

Away from the stream, the vegetation was dominated by open grasslands of rough fescue and bluebunch wheatgrass (the state grass). Many other grassland species also were common. Montana's state tree, Ponderosa pine, was scattered throughout the grasslands of the lower drainage, particularly on "islands" of sandy soils.

Once white men settled the area, vegetation changes occurred rapidly. Trees were cleared for farmland, building materials, and fuel. Livestock were grazed at rates beyond what the native plants could tolerate. As native species declined, introduced grasses such as cheatgrass and Kentucky bluegrass took over. Riparian shrubs became sparse and few plants could stand the constant grazing pressure of streamside locations. Kentucky bluegrass, Baltic rush and other introduced species came to dominate many riparian areas.

PONDEROSA PINE GROWING ON
A BEDROCK ISLAND WEST OF KILA

Some researchers believe that these dramatic changes in local plant communities occurred because the native plants had not evolved under intense grazing pressure. Therefore it only took a brief period of overuse to severely reduce the abundance of native species. Present vegetation conditions do not necessarily reflect poor management by the current owners. It takes only a short period of severe overuse to dramatically alter the plant cover. Once altered, it is difficult and time consuming to reestablish native plant species. Revegetation of streambanks and reintroduction of native plants is difficult and requires a combination of healthy seed or rootstock, proper planting techniques and appropriate weather.



THE VEGETATION OF LOWER ASHLEY CREEK LOOKED MUCH DIFFERENT WHEN WHITE MEN FIRST ARRIVED

STREAMBANK MANAGEMENT: Benefits for All

The list of benefits gained from well-managed streams is endless. Some of the values and activities stream management can affect include:

- Fishing
- Recreation
- Property values
- Water quality
  - Sediment
  - Sewage pollution
  - Chemical pollution
- Weed control
- Wildlife
- Education

Fisheries

Although many people are not enthusiastic fishermen, most agree that fish deserve a decent place to live. Fishing provides personal enjoyment for the individual and recreational income for the community. Proper streambank management benefits fish by maintaining water quality.

Many fish have restrictive temperature and shade requirements. Removing streamside vegetation increases temperatures and decreases shade. When streamside vegetation is removed, bank erosion increases and sediment is produced which may cover important spawning gravel, increase water temperatures, or affect fish directly.

Sediment Control

Sediment is not just the dirt in water which makes some streams brown or milky-colored. Sediment is the silt and clay transported in suspension by water. Sediment is also the sand, gravel and cobbles bouncing along the stream bottom as bedload. The size and amount of sediment a stream can transport is called the sediment-carrying capacity, and depends primarily on the velocity and quantity of water. Velocity is inversely related to two other stream characteristics, width and depth. A change in width, depth or velocity either increases or decreases the sediment-carrying capacity of a stream. Stream gradient is another important factor related to velocity and sediment-carrying capacity.

UNVEGETATED, TRAMPLED, ERODING BANK

When velocity slows, sediment-carrying capacity decreases and sediment is deposited. Velocity slows whenever a stream suddenly widens. This is most evident when stream velocity decreases upon reaching a lake. There is a sequence of deposits sorted by decreasing velocity at that point. Large gravel are deposited first, then sands. Further out in the lake silt and then clay will settle out.

Lakeshore property owners are often distressed to discover that their lake is decreasing in size due to sedimentation. Those most affected are usually near streams which are carrying sediment into the lake. Ashley Lake is currently being filled by this process, and several long-time residents have periodically dredged sediment from boat dock and swimming areas. New requests for dredging are discouraged by local lakeshore regulations administrators and by the Army Corp of Engineers. Dredging is harmful because it increases the total suspended sediment and may harm fisheries or other resources. The sedimentation or filling in of lakes is a natural process which is accelerated by poor streambank and land management. Activities such as timber harvest, road construction, livestock trampling banks, tillage and vegetation removal can all increase sediment production. It may be more beneficial to reduce these sediment sources instead of dredging the lake.

When stream velocity and volume increase, sediment-carrying capacity also increases. The stream reacts by scouring its banks and bed at that point. Velocity is most often increased by constricting the flow to a narrower channel. This increased erosion may start a headcut which appears as a small riffle or waterfall that migrates upstream. A headcut can alter meander and flow patterns above the site. It is important for project planners to remember that their actions can have significant impacts upstream as well as downstream.

Some harmful effects of sediment are obvious, such as damage to fisheries by covering spawning gravel or clogging gills. But there are other less visible effects caused by sediment. Too much sediment may alter the pattern of erosion and deposition downstream resulting in undesired shifts in the streambed. Sediment can clog pumps and increase maintenance and repair costs. Sediment may contain nutrients which stimulate undesirable algae and aquatic plant "blooms". It may also represent the loss of the most productive soil layer, the topsoil.

Vegetated Streambanks

Well-vegetated streambanks slow the erosion process and reduce the number and intensity of bank erosion or migration events. A dense cover of grasses, sedges, rushes, dogwood, willow and other plants is the most cost-effective investment in streambank protection. Shrubs and trees are especially important for providing shade and reducing stream temperatures. In some situations where rock riprap or other material is considered, revegetation can be a worthwhile alternative. Revegetation efforts may not prevent all additional bank loss but they can slow erosion. Vegetation must be lush and diverse in order to hold the bank in place and act as a filter for runoff or other inflow. Mowing up to or near the streambank does not provide the desired effects.

ASHLEY CREEK WEST OF SMITH LAKE

Weed Control

Weeds will quickly invade any bare soil along streambanks. These weeds decrease streambank values for livestock and wildlife by replacing forage and cover plants. Some weeds completely take over a site to the exclusion of all other vegetation, while other weeds are poisonous. Weeds are very expensive to eradicate from streambank sites. Eradication may be impossible at some locations or require methods such as herbicide applications which are environmentally inappropriate. It is especially important to keep streambanks free from weeds because seeds are easily carried downstream to infest other sites. They may also be carried by the many animals which visit streambank environments, including people.

Education

Well-managed streams add to the quality of life in many subtle ways. A healthy riparian corridor provides homes or niches for birds, insects, reptiles, and other creatures. The complexity of these habitats offers students many opportunities to learn about natural systems within a small area.

Spirit of Cooperation

One rarely considered benefit of good streambank management is the reduction of streambank disputes between neighbors. When banks are managed to reduce erosion and remain stable, controversies are less likely to develop. As landowners work together to improve local streambanks they can create an air of cooperation. This cooperative atmosphere may help them through more difficult periods, such as when the stream makes a dramatic alteration in its course or behavior. The most difficult situations often occur when one landowner is losing land and another is gaining. Working together and getting the best technical help possible should allow the community to predict and plan for the worst calamities - natural, political and legal.

Living With Ashley Creek

A stream is dynamic. Seen every day, it is easy to be lulled into thinking it will always be the same. Anyone who has witnessed a flood knows how radically and frighteningly a body of moving water can change. A change in one part of a stream will cause a change somewhere else. For example, erosion of a bank will cause sedimentation downstream. Altering a stream channel will cause changes in flood activity and meander pattern. These effects are difficult to predict, and may occur upstream or downstream.

Long-term planning and community cooperation are needed to successfully avoid problems along Ashley Creek. Ignoring stream dynamics can cause massive headaches, including personal animosities and lawsuits.

ASHLEY CREEK CROSSING AT HWY 2 NEAR ASHLEY LAKE ROAD

ASHLEY CREEK STREAM DATA: The Numbers

Ashley Creek is a small stream, averaging 5-15 feet wide and 2-4 feet deep. Occasional pools are wider and deeper. The creek is generally wider and deeper below Snowline Lane southeast of Kalispell. For much of its course, Ashley Creek is slow-flowing and has a very low gradient. Floods have not been frequent or destructive. Water rights filed on the creek far exceed the amount of water available. Ashley Creek provides habitat for many different fish and opportunities for various forms of recreation.

Streamflows: How Much Water Is There?

Streamflow is measured in cubic feet of water per second (cfs). One cfs is equal to 450 gallons per minute or 650,000 gallons per day. One cfs flowing for 12 hours will supply a family of five for a year.

Limited flow data is available for Ashley Creek. The available data were collected in different locations over various years. Figure 5 illustrates the locations of stream gauges in use by the Montana Department of Fish, Wildlife and Parks at the time of this report.

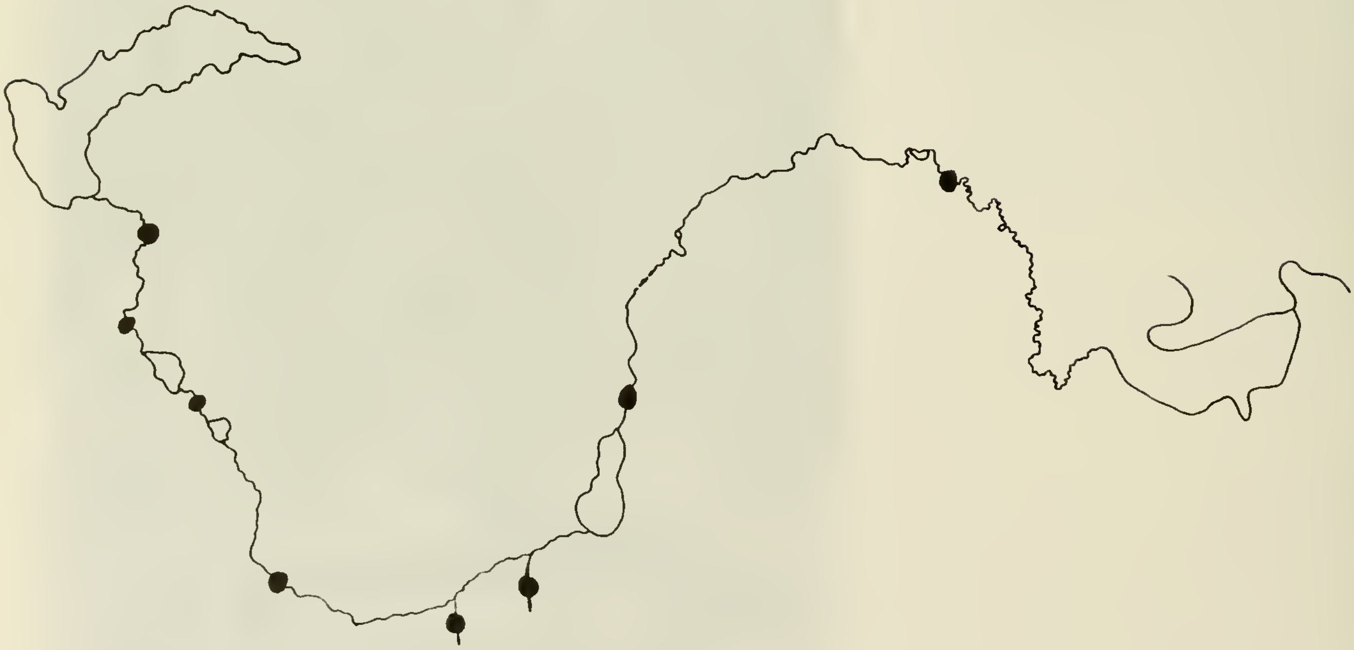
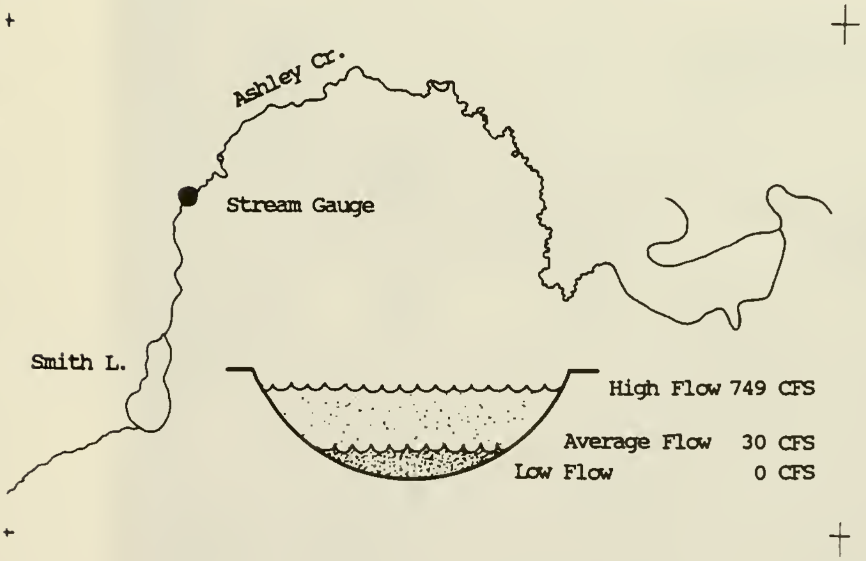


Figure 5. Locations of current streamgauges (MDFWP).

In addition to stream gauges, the USDA Soil Conservation Service monitors snowcourses at five locations in the upper watershed. These data may be used to predict streamflow and flood characteristics.

Records from two gauging stations are used to illustrate general flow characteristics. These records do not represent flows expected during large floods. The maximum flow ever recorded for Ashley Creek was much less than the predicted 100 year flood.

From 1931 to 1950 a stream gauge was maintained 2.5 miles below Smith Lake. The average flow at this gauge was 30 cfs. Maximum discharge was 749 cfs (May 27, 1948). Minimum discharge was 0 cfs or no flow which occurred in the summer months when all water was drawn off for irrigation. Ashley Creek was often completely dewatered by irrigators until the Department of Fish, Wildlife and Parks began coordinating flows. The average annual discharge from the watershed is about 22,000 acre-feet but has fluctuated from 1,080 cfs (1940) to 79,000 cfs (1948).



From August to November of 1961, a stream gauge was maintained 1.5 miles downstream from Ashley Lake. Streamflow ranged from 4 cfs (September 29th) to 20 cfs (August 9th). This measurement period does not include spring runoff.

Three years of continuous gauging at Meridian Road in Kalispell revealed an average monthly flow ranging from about 10 cfs in August to almost 100 cfs in April and May. March and June were the only other high runoff months, averaging 70-80 cfs. Additional flow information is presented in Appendix 8.

TABLE 1--Ashley Creek Streamflows Compared With Other Local Streams (figures adapted FEMA 1984)

	Drainage Area (square miles)	Average Flow (cfs)	Highest Recorded Flow (cfs) {year}	Projected 100 Year Flood (cfs)
Ashley Creek (near Kalispell)	280	34	749 {1948}	1,430
Bear Creek (near Essex)	20		1,840 {1975}	1,990
Stillwater River (near Kalispell)	146	396	4,330 {1964}	6,200
Whitefish River (near Kalispell)	177	290	1,290 {1964}	1,600
Flathead River (near Columbia Falls)	4,464		176,000 {1964}	84,500

Table 1 reveals that the highest recorded flow for Ashley Creek is about half of the predicted 100 year flood level. This indicates that we really haven't seen a big flood yet on Ashley Creek. The true magnitude of a 100 year flood is unknown.

The highest recorded flow and the predicted 100 year flood are much smaller for Ashley Creek than for Bear Creek, even though the Ashley Creek watershed is 140 times larger. This is due to many factors including precipitation, elevation, soils, and vegetation.

The Montana Department of Fish, Wildlife and Parks currently controls the flow of Ashley Creek as it leaves Ashley Lake. Flow is regulated with a small earth and concrete dam structure. This dam was constructed about 1928 and has a steel and wood head gate. The department plans to replace the structure in the next few years.

FLOW CONTROL STRUCTURE AT
ASHLEY LAKE

Ashley Creek: The Floodplain

Floods are discussed in terms of their frequency, or how often a given size flood will occur. A 100 year flood is the maximum flood level expected to occur throughout a 100 year period. The 50 year flood event is smaller and represents the maximum flood level or flow which is expected to occur during a 50 year period. On Ashley Creek, the 100 year flood is about one and a half times the volume of the 50 year flood. Floodplain studies usually list flood levels for the 10, 25, 50, 100 and 500 year events. It is best to remember that flood frequency estimates are statistical `guesses'. We could actually experience a 100 year flood several years in a row. True flood heights are affected by any alteration of streambanks and these effects are difficult to predict ahead of time.

Figure 6 illustrates predicted flood levels for Ashley Creek. These levels are shown in general relation to a "typical" cross-section of the stream immediately above Kalispell. In the section of Ashley Creek that flows through Kalispell, the 10 year flood has a depth of about 7 feet, the 50 year flood 9 feet, the 100 year flood 10 feet and the 500 year flood 16 feet. The distribution of these floodwaters in relation to bank height and other terrace levels is determined by many site-specific factors.

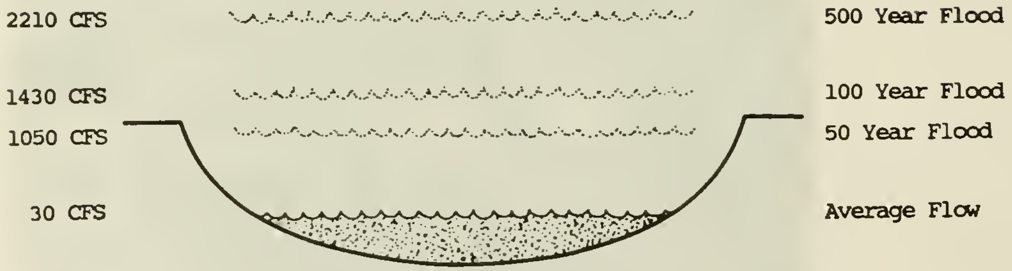


Figure 6. Predicted flood levels for Ashley Creek at Kalispell.

Floods on Ashley Creek have not been as severe as on other local streams. The lakes along Ashley Creek help reduce flood hazards and severity by storing floodwaters and slowing velocity. Other factors which reduce flood severity include the low elevation of the watershed, a dominance of forest vegetation and a high moisture-holding capacity of many local soils. The low elevation means relatively low precipitation and floodwater. Forest vegetation intercepts and stores large volumes of water on leaf and stem surfaces, then releases it slowly into ground and surface water systems. Forest vegetation produces a litter layer on the soil surface which accepts water readily and slows runoff. The high moisture-holding capacity of many soils also acts as a buffer to slow the rate of runoff.

In the Kalispell area, major flooding occurred during 1894, 1928, 1933, 1948, 1964 and 1975.

1948

The largest measured flood on Ashley Creek occurred in 1948 and was approximately a 25 year flood event. This flood was caused by the combined effects of above normal precipitation, cool temperatures during the early snowmelt season, and an abrupt warming trend in mid-May with temperatures in the 70s and 80s. Ashley Creek peaked at 749 cfs on May 26th (three days after the Flathead River and one day before the Whitefish River). This compares with an average flow of only 30 cfs and an average spring peak discharge of 300 to 400 cfs.

1964

In 1964, 25,000 acres flooded along the Flathead River and property damage in western Montana reached 25 million dollars. During a 30 hour period, over 15 inches of rain fell on parts of the Flathead drainage. There was little or no flood damage along Ashley Creek in 1964.

1975

In 1975, 200 mobile homes and 50 other residences along the Flathead River were flooded, moved, or surrounded by water. During this same "flood year", Ashley Creek peaked at a relatively low level with limited flooding. No homes were threatened in the Ashley Creek drainage during the 1975 flood.

Floodplain maps for the lower 17 miles of Ashley Creek have been published by the U.S. Federal Emergency Management Agency and can be viewed at the Kalispell Regional Development Office. In general, the Ashley Creek floodplain is very narrow along most of its length. Floods are mainly restricted between well-defined, high banks which are easily observed in the field. Most builders along Ashley Creek have recognized the significance of these high banks and have located structures above them. The floodplain area widens where side drainages enter Ashley Creek and also along the lower portion of the stream. Since large flood events have not been recorded on Ashley Creek, the true magnitude of a large flood remains unknown. Floodplain uses along Ashley Creek should continue to be monitored.

For more information on floodplains please contact:

* Flathead Conservation District
* Flathead Regional Development Office (county floodplain administrator)
* Montana Department of State Lands
* U.S. Army Corp of Engineers

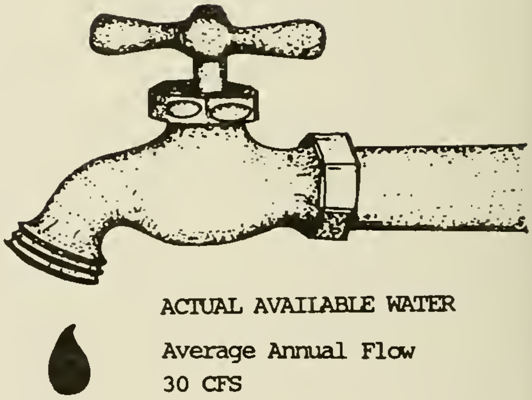
Water Rights: Who Owns the Water?

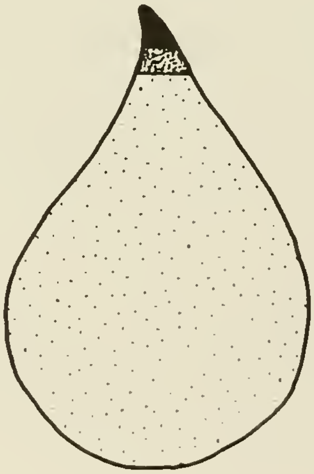
Joe Ashley was probably the first white man to use water from Ashley Creek (1850s). The earliest water right on record dates to 1885.

In 1897, the Ashley Irrigating Company was formed with 14 area farmers listed as appropriators. The company was reorganized in 1909 under the rules of a new Irrigation District law and issued $50,000 in bonds for improvements. These improvements included the Ashley Irrigation Ditch, which was 12 miles long and had a capacity of 75 cfs. In 1964, there were 48 water users on the ditch and water rights totaling 1250 cfs. At this time about 2700 acres were irrigated by ditch water. Most of these lands were outside the Ashley watershed to the north. Local rumor suggests that the ditch never did pay for itself in terms of the original cost or annual maintenance. Local investors are said to have suffered significant financial losses associated with the ditch.

The ditch leaked severely in areas of sandy glacial outwash and windblown soils. Maintenance was ignored in recent years and leakage prevented water from flowing very far through the ditch. The ditch is no longer in use.

Figure 7. Water rights filed on Ashley Creek.





The 1965 Water Resources Survey of Flathead County lists 307 water rights filings on Ashley Creek for a total of almost 4000 cfs. The average streamflow is only 30 cfs and the creek was dewatered by irrigation consumption many times in the past. This dewatering should become less frequent with current efforts by the Montana Department of Fish, Wildlife and Parks (MDFWP).

In 1978, a group of government agencies, corporations and individuals purchased the Ashley Lake dam and all water rights from the Ashley Irrigation District. Total purchase price was $50,000 and these rights have a priority date of 1897. All other water rights filings are junior to them which gives this group significant control of water use (Figure 7). In this transaction, the MDFWP purchased a total of 11,448 acre feet which converts to an average annual instream flow of 15.8 cfs. Approximately 13.2 cfs is designated for fish and wildlife, and 2.6 cfs for sewage dilution. The remaining 15 parties purchased a total of about 10 cfs. The MDFWP monitors flow with a series of stream gauges (Figure 5) to insure maintenance of its instream water rights.

For more information on water rights contact:

- Montana Department of Natural Resources and Conservation, Water Rights Bureau
- Montana Department of Fish, Wildlife and Parks

Ashley Creek Water: How Clean Is It?

Ashley Creek has both natural and man-caused water quality problems (Table 2). In some reaches near Smith Lake, decomposing organic matter turns the water brown. Phosphorous and other pollutants increase the growth of unwanted aquatic organisms and inhibit fish survival. A hodgepodge of water quality data are available for Ashley Creek which include various sampling methods, data, and analyses.

A comprehensive analysis of all data is beyond the scope of this report. We have chosen to summarize the most obvious and important relationships. Additional water quality information is presented in Appendix 5.

Streams are classified into water quality groups by the Montana Water Quality Bureau (Figure 8). This system identifies "beneficial uses" and sets water quality standards for each class.

Ashley Creek water quality declines as you travel downstream. From Ashley Lake to Smith Lake the stream is classified as B-1, which includes waters suitable for drinking, culinary use and food processing after conventional treatment. These waters are also suitable for bathing, swimming and recreation, for salmanoid fisheries, industry, agriculture and certain other uses.

From Smith Lake to the Kalispell sewage treatment plant the stream is classified as B-2, which is similar to the B-1 classification except that salmanoid fisheries are marginal.

Below the Kalispell treatment plant, the stream has a C-2 rating, which prohibits use as a drinking water supply or for food processing purposes and is marginal for salmanoid fisheries. Each of these categories has a long list of specific water quality guidelines for potential contaminants.

When examining water quality data, it is important to remember that streamflow will radically influence pollutant concentrations by providing more or less water for dilution. Temperature will also affect water quality since the solubility of oxygen and other substances is influenced by temperature.

Table 2-- Ashley Creek Pollutants and Their Sources

Kalispell Sewage Treatment Plant
nitrates
phosphates
ammonia
coliform
heat

(Note: The plant serves about 10,000 people and has a flow rate of about 1.5 million gallons, a BOD of over 300 lbs./day, and a total phosphorus load of over 90 lbs./day.)

Urban Runoff - Storm Sewers
salts
grease and oil
pesticides
fertilizers
sediment
heavy metals

Industry
tannic acid
phenols

Agriculture
sediment
fertilizers
pesticides
animal wastes

Feedlots & Corrals
coliform
nitrates

Forestry
sediment

In 1977, water quality data was published for 8 sites along Ashley Creek as well as for sites on other local streams (Morrison and Maierele 1977). Figure 9 uses several water quality parameters from this study to illustrate how quality deteriorates downstream. Since 1984, nitrogen and phosphorous data have been collected both above and below the sewage treatment plant (Pers. Comm. Jack Stanford, Flathead Biological Station). Table 3 illustrates the sharp contrast in values reported by this monitoring effort.

Figure 8. Water quality classifications for Ashley Creek (Montana Quality Bureau).

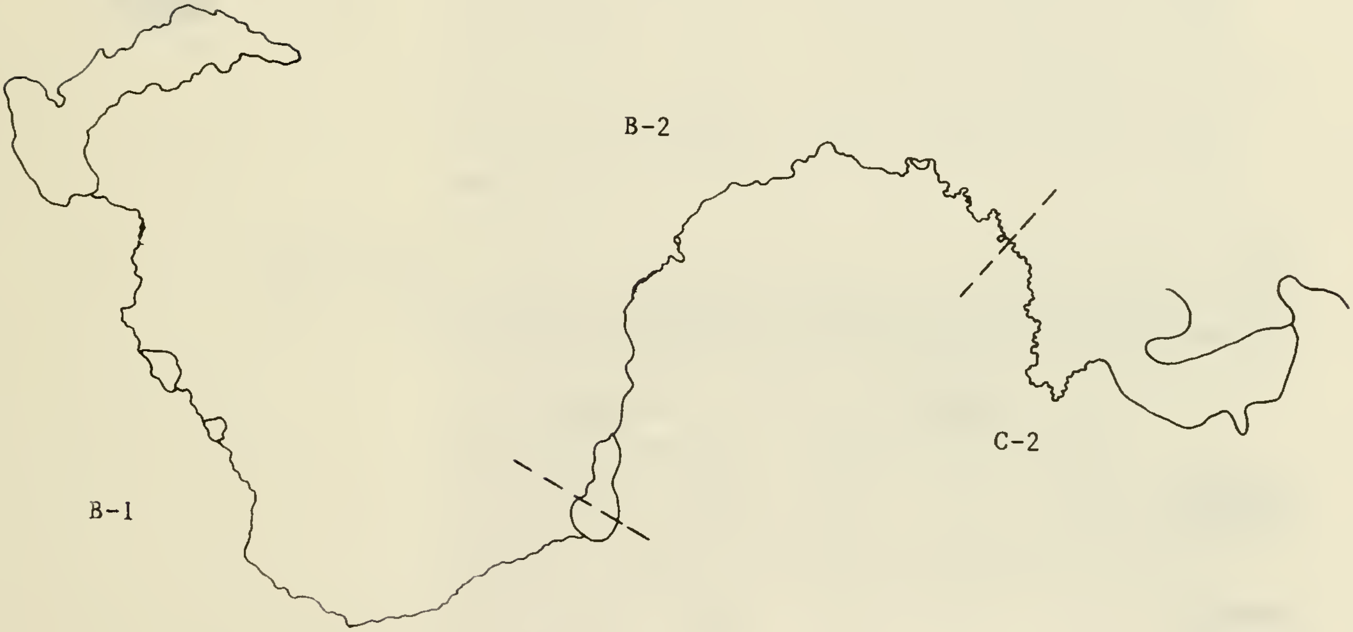


Figure 9. Water quality along Ashley Creek in the 1977 study (Morrison and Maierle).

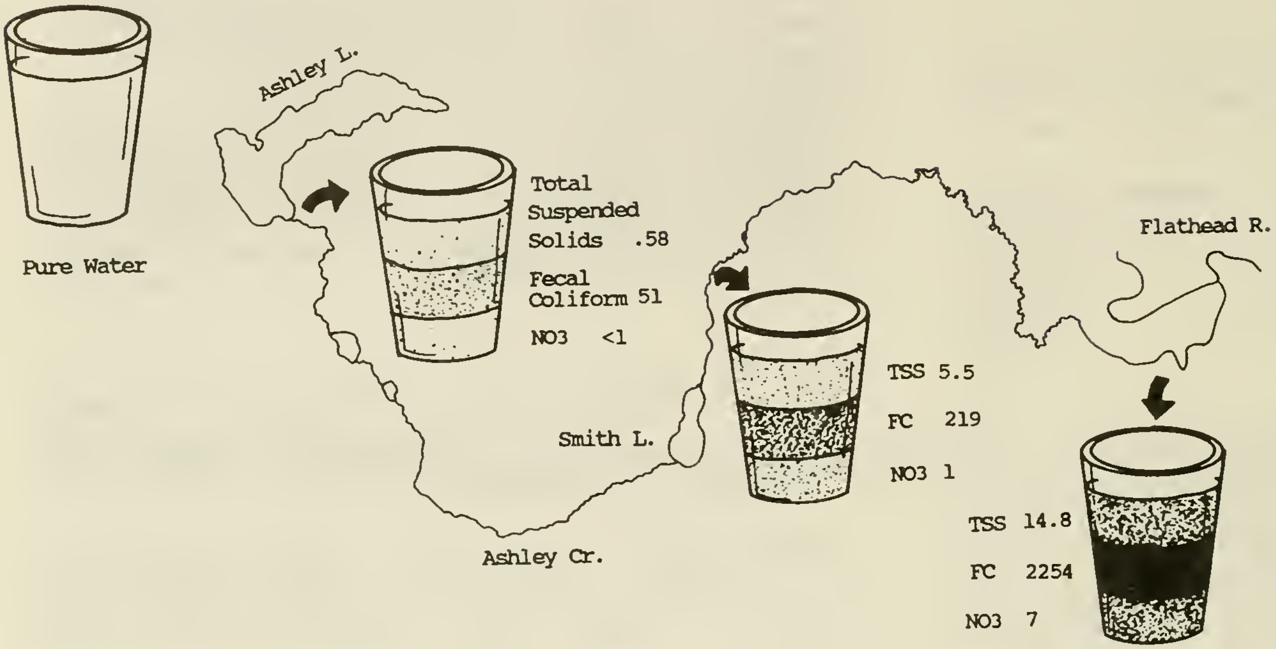


Table 3--Water quality parameters above and below the Kalispell sewage treatment plant 1984-87 (Pers. Comm. Jack Stanford. All values are in ug/l of nitrogen or phosphorous).

	ABOVE			BELOW		
	HIGH	MEAN	LOW	HIGH	MEAN	LOW
NITRATE NITROGEN	208	67	<10	2841	710	27
AMMONIA NITROGEN	0	0	0	1918	431	17
TOTAL PHOSPHOROUS	111	69	41	1680	431	138

Several water quality parameters deserve special mention. Each of these characteristics or pollution forms are briefly described in relation to Ashley Creek and recommendations are made for reducing each problem.

Dissolved Oxygen and BOD (Biological Oxygen Demand)

Fish and other aquatic animals need oxygen to survive. Organic matter added to water is decomposed by micro-organisms, which use up oxygen in the process. The amount of oxygen needed to decompose a given amount of organic matter is the Biological Oxygen Demand (BOD). When too much organic matter is present, microbes use up the available oxygen.

Smith Lake and its adjacent wetlands are a natural source of BOD on Ashley Creek. The Kalispell sewage treatment plant is the largest documented unnatural source of BOD, adding 150 to 200 mg/l to the creek. Dissolved oxygen levels are near saturation (8-10 mg/l) immediately above the treatment plant. The lowest dissolved oxygen levels below the plant have been less than 1 mg/l and average 1-5 mg/l. Organic-rich runoff from corrals and pastures is another unnatural source of BOD on Ashley Creek. Oxygen depletion may be a significant barrier to fish movement below the sewage plant, at least during certain times of the year.

BOD from the sewage plant can be reduced by improved treatment such as better aeration. Organic-rich runoff can be reduced by restricting livestock access and by proper water management to prevent runoff. Buffer strips, sediment traps and grassed waterways are methods of "cleaning up" runoff before it reaches the stream. There have not been any practical solutions proposed for reducing the BOD from organic deposits in the Smith Lake area. Dissolved oxygen concentrations may also be raised by reducing the water temperature.

Nitrogen

Nitrogen is a basic building block of all proteins and therefore of all life. It is one of the most common limiting factors for growth in aquatic ecosystems. Nitrogen additions usually cause immediate increases in algal growth and can harm fish populations in several ways. Nitrogen most commonly occurs in water as the nitrate form

(NO3), and less commonly as ammonia (NH3). Nitrate levels above 10 milligrams/liter (mg/l) are considered unsafe for drinking water. Pregnant women and infants are even more sensitive to nitrates and debate continues about whether any level of consumption is safe for them. Concentrations above 500 mg/l are unsuitable for livestock watering.

In the 1977 study, nitrate concentrations were less than 1 mg/l in the upper Ashley drainage but increased dramatically below the sewage plant. The more recent study revealed average concentrations of total nitrogen (as nitrate) above the treatment plant of 67 micrograms per liter (ug/l). Concentrations averaged 710 ug/l below the plant and ranged as high as 2841 ug/l. Ammonia nitrogen was rarely detectable above the plant but averaged 431 ug/l below. On three sampling dates, ammonia levels exceeded 1000 ug/l which is probably toxic to most fish and would create a barrier to movement during those times.

ASHLEY CREEK WEST OF KILA

Nitrogen levels can be reduced through improved sewage treatment, restricted livestock access, and proper water management to reduce runoff. Buffer strips, sediment traps, and grassed waterways are all methods of `cleaning up' runoff before it reaches the stream.

Phosphorous

Phosphorous helps to transfer energy within all living cells and is often the most limiting nutrient in local aquatic ecosystems. Phosphorous occurs in water environments as phosphate (PO4). Most phosphates in water come from domestic wastes, especially detergents. Other sources include industry, forestry and agricultural runoff. Phosphorous bonds to soils particles and is often present in sediment pollution. Phosphate additions usually cause immediate increases in aquatic plant growth (blooms).

The major sources of phosphorous in Ashley Creek are detergents and other household wastes. The Kalispell sewage treatment plant adds about 90 lbs. of phosphorous to Ashley Creek each day. The most recent water quality sampling (Table 3) indicated an average total phosphorous concentration of 69 ug/l above the treatment plant. Below the plant, total phosphorous averaged 431 ug/l with a range of 138 to 1680.

Phosphorous has been a major local issue in recent years due to its effects on Flathead Lake. Two-thirds of the biologically active phosphorous reaching Flathead Lake is estimated to be from point sources such as the Kalispell sewage treatment plant (Bahls 1986). This is the phosphorous responsible for "blooms" of aquatic organisms, especially blue-green algae.

Phosphate-containing detergents have been estimated to represent about 17% of the total biologically active phosphorous load to Flathead

DUCKWEED-ALGAE ACCUMULATION BELOW THE KALISPELL SEWAGE TREATMENT PLANT lake. In 1985, Flathead County adopted a local regulation banning the sale of detergents which contain phosphorus. Phosphorous output from the sewage treatment plant has shown a significant reduction since the ban. Efforts should be made to further reduce phosphorous in sewage effluent.

Other sources of phosphorous in Ashley Creek include sediment from a variety of sources and runoff from agricultural, industrial and urban sites. Phosphorous is often bonded to soil particles, especially volcanic ash. Roads and other disturbed areas are the most common local sources of phosphorous-containing sediment. These sources can be reduced by restricting livestock access and by proper water management to prevent runoff. Buffer strips, sediment traps and grassed waterways can be used to reduce the amount of phosphorous in runoff before it reaches the stream.

Color

Color is most often caused by suspended sediment and organic matter. Color which is caused by sediment usually appears similar to the color of the sediment itself. Color caused by organic matter is usually chocolate brown or coffee-colored. Ashley Creek has a light brown organic color where it leaves Smith Lake. This color probably results from organic deposits in the Mountain and Truman creek drainages and the area surrounding Smith Lake. The distribution and magnitude of these deposits makes it unlikely that there is an easy method for reducing their color contributions.

TSS (Total Suspended Solids)

Total suspended solids (TSS) are the sediments carried in suspension by water. TSS reduce light penetration, increase temperatures and cover spawning gravel. Concentrations above 90 mg/l may harm fish directly. TSS include sediments eroded from streambanks, sediment in storm water, solids from sewage treatment plants, and other materials.

TSS are very low in the upper Ashley Creek drainage but increase steadily throughout the urban and lower agricultural areas. As sediment-laden waters reach each lake on Ashley Creek, the slowing water drops its sediment load. In this way, each lake acts as a settling basin or sediment trap. This same effect occurs where the influence of Flathead Lake causes the flow to slow down east of

EROSION ALONG A
POORLY-DESIGNED ROAD

Kalispell. These influences cause most of the Ashley Creek streambed to be silty instead of gravelly. Silty streambeds offer very little opportunity for salmanoid spawning.

The most effective way to reduce total suspended solids in Ashley Creek is to revegetate the streambanks. Sedimentation can also be reduced by restricting livestock access and managing the stream to reduce sediment-laden runoff. Buffer strips, sediment traps and grassed waterways can be used to capture sediment before it reaches the stream.

Silt is the major sediment carried by Ashley Creek due to the dominance of silt-sized particles in local soils. The amount of sediment carried by Ashley Creek is limited by Ashley, Lone, Monroe and Smith Lakes which act as sediment traps.

Temperature

Temperature affects most aquatic organisms and inorganic chemical reactions. Small changes in stream temperature may have substantial impacts on plants and fish. Temperature may increase due to unvegetated banks which are not shaded. Sediment-laden water becomes warmer by collecting more solar radiation than clear, clean water. Sewage plant effluent may also increase temperature. Increased water temperature has often been referred to as "heat pollution" because it reduces salmanoid fisheries. As fisherman come to appreciate less exalted fish, this view of warm water as evil may change.

Ashley Creek temperatures vary seasonally and spatially. Shallow lakes along Ashley Creek dramatically increase water temperature, which is reflected in the type of fish commonly found along certain stretches. The temperature of surface waters released from Ashley Lake range above 70 F during summer months. Ashley Creek has a diverse fishery resource in part because it has a range of temperature habitats, each favoring certain fish.

Revegetating Ashley Creek streambanks could have a significant effect on water temperatures in some sections. Temperature is directly related to other important water quality parameters, especially dissolved oxygen. Reducing temperature can significantly increase dissolved oxygen content. Overhanging vegetation, especially shrubs, may lower temperatures by several degrees. Further cooling of sewage treatment plant effluent may also help reduce temperatures during certain times of the year.

pH

Acidity or alkalinity is measured on the pH scale, where 7 is neutral, larger numbers are more alkaline and smaller numbers more acid. The pH of streams is usually near neutral, with some exceptions. Stream water pH is most affected by the bedrock. Where `alkaline' rocks such as limestone, dolomite, and rhyolite are common, pH is high or alkaline. Where `acidic' rocks such as granite and andesite are common, pH is low or acidic. The pH of rainfall and snow can also affect stream waters, as in the case of acid rain. Ore bodies may also influence pH, usually making the affected waters more acidic.

The pH of Ashley Creek averages between 7 and 8, or neutral to slightly alkaline. Acid rain is unlikely to become a problem on Ashley Creek because the watershed is dominated by limestone and the soil materials contain abundant lime. This provides a tremendous buffering capacity for acid precipitation. This buffering capacity may also help to offset the acidic effects of organic deposits in the Ashley drainage. Unless large mining or industrial developments locate on Ashley Creek, it is unlikely that humans will significantly affect pH.

Aquatic Plants

Fish habitat and the aesthetic appearance of a stream are degraded by excessive amounts of algae and other aquatic plants. These plants are common to most streams, but in limited amounts. Excess nutrients, especially phosphorous and nitrogen, can stimulate "blooms" of aquatic plants. Duckweed, blue-green algae, and other plants commonly reach epidemic or "bloom" levels in lower Ashley Creek during the warmer months. This problem is most evident below the sewage treatment plant. Phosphorous is believed to be the primary cause of these blooms. The problems caused by algae and other aquatic plants can be reduced by limiting their food supply. All activities which reduce phosphorous, nitrogen and other nutrients will help control the growth of unwanted plants.

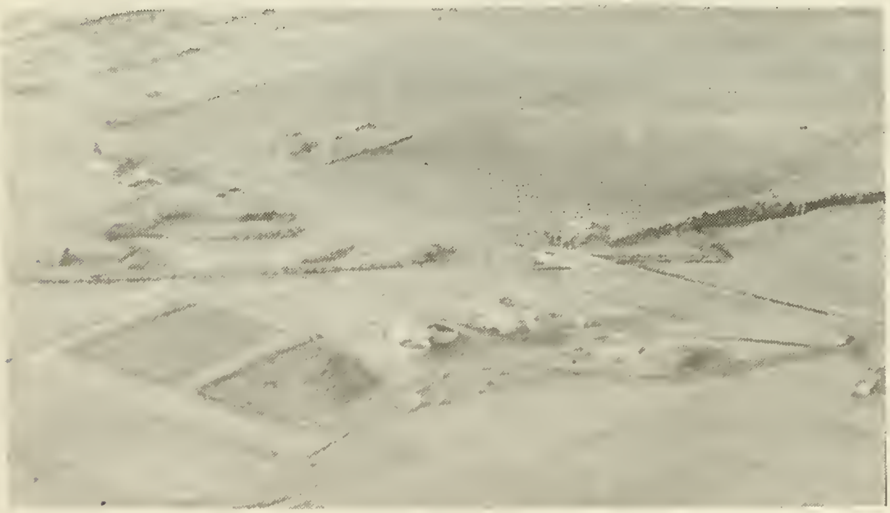
Fecal Coliform

Fecal coliform are a common bacteria found in the intestines of warm-blooded animals. While not harmful themselves, these bacteria suggest the presence of more dangerous, pathogenic organisms. Fecal coliform is usually absent from `clean' drinking water and its presence suggests contamination by human or animal wastes. The most common sources of contamination are septic systems, sewage treatment plants and livestock operations.

During the 1977 water quality study, fecal coliform fluctuated between 50-200 colonies/100 milliters above Kalispell. Below the sewage treatment plant the level skyrocketed to 2,500 colonies/100 mls. The Kalispell sewage treatment plant is the largest single source of coliform on Ashley Creek. Individual onsite sewage treatment systems probably contribute little coliform to Ashley Creek except where they are located in sandy soils with rapid permeabilities.

The second major source of coliform on Ashley Creek is livestock. Animal wastes may be deposited directly into the creek or wash overland during rain and snowmelt events.

Coliform and related pollution can be controlled by improving sewage treatment plant performance. Pastures, corrals, feedlots and packing plants should manage animal access and runoff to prevent this pollution. Buffer strips, sediment traps and grassed waterways can also help reduce the amount of coliform in runoff.



KALISPELL SEWAGE TREATMENT PLANT

Phenols

Pentachlorophenol and other phenol compounds are used extensively for preservation of bridge structures, utility poles and other woods used in water and soil. During recent years, these compounds have been found in water supplies nationwide and are believed to increase the possibility of birth defects and certain cancers. Concentrations above 1 microgram/liter (ug/l) are considered detrimental to freshwater environments.

The 1977 water quality study revealed phenols in Ashley Creek. More detailed study showed elevated levels (3-6 ug/l) throughout the stream near Kalispell. Additional investigation is necessary to identify the source of these phenols and determine how to eliminate them.

Point Pollution Sources

Several point sources of potential pollution deserve special mention. The Kalispell sewage treatment plant is the most obvious and has been discussed in terms of its effect on dissolved oxygen, phosphorus, nitrogen, and temperature.

The Kalispell storm sewer system is another significant source of pollution. Although this water is collected from a large area and is usually considered nonpoint pollution, the storm drain system empties into Ashley Creek at two specific points via large pipes. These waters carry sediment, petroleum products, salts, pesticides, fertilizers, and other pollutants. Occasionally, a significant quantity of petroleum product is spilled due to an auto accident or other incident and is washed into the storm sewer. Residents who do not understand the direct relationship of the storm sewer to the creek may occasionally dispose of hazardous wastes down storm drains.

A lumber mill and a meat packing plant border Ashley Creek near Kalispell. Both are potential sources of phenols, organic matter, coliform, nitrates, and other undesirable materials. The effect of these businesses on the creek has not been studied in detail.

Improving Stream Water Quality

Water quality in Ashley Creek will continue to be a very important and visible issue. The Kalispell sewage treatment plant is the largest point source of pollution and should continue to receive public attention. Plant improvements will soon include better phosphorous treatment. A project to pipe the treatment plant effluent directly east to the Flathead River was proposed in recent years but rejected. This may be fortunate for Flathead Lake since the lower creek probably provides an environment for some treatment of sewage plant discharges. Studies are underway to further understand and reduce the effects of sewage plant effluent on Ashley Creek. A Flathead County ban on phosphate-containing detergents has already reduced phosphorous levels in the sewage plant effluent. The role of Smith Lake in Ashley Creek water quality is poorly understood and deserves closer study.

Convincing private landowners to reduce urban and livestock runoff should significantly improve water quality. A notable improvement in water quality might be achieved simply by providing well-vegetated buffer strips along the entire stream and preventing harmful runoff from entering the water. Water quality also benefits from maintaining as much flow in the stream as possible, as this dilutes harmful pollutants. Necessary efforts should be made to maintain or increase stream flows to improve water quality.

For more information on water quality please contact:

- Flathead Conservation District
- Montana Department of Health and Environmental Sciences, Water Quality Bureau
- Montana Department of Fish, Wildlife and Parks
- Flathead Biological Station

Fishery Resources: Where To Catch the Big Ones

The Ashley watershed provides a wide range of habitats for both cold and warm water fish (Figure 10). The most common fish in Ashley Lake include cutthroat and rainbow trout, kokanee salmon, yellow perch, peamouth, and finescale suckers. A few grayling also occur in Ashley Lake.

Monroe Lake is dominated by red shiners, peamouth, and yellow perch with a rare kokanee salmon, grayling, rainbow or cutthroat trout.

Common species in Lone Lake include northern pike, cutthroat trout, peamouth, suckers, pumpkinseed, redside shiners and northern squawfish.

Surface water discharged from Ashley Lake during the summer ranges from the upper 60s (F) into the lower 70s. These temperatures are marginal for supporting salmanoids such as cutthroat, grayling, or rainbow trout and affect the stream segment between Ashley and Monroe Lakes. However, the resident salmanoid population in Lone Lake does use this stream segment for spawning. Nongame species such as peamouth and red shiner are the dominant inhabitants from Ashley to Monroe Lake.

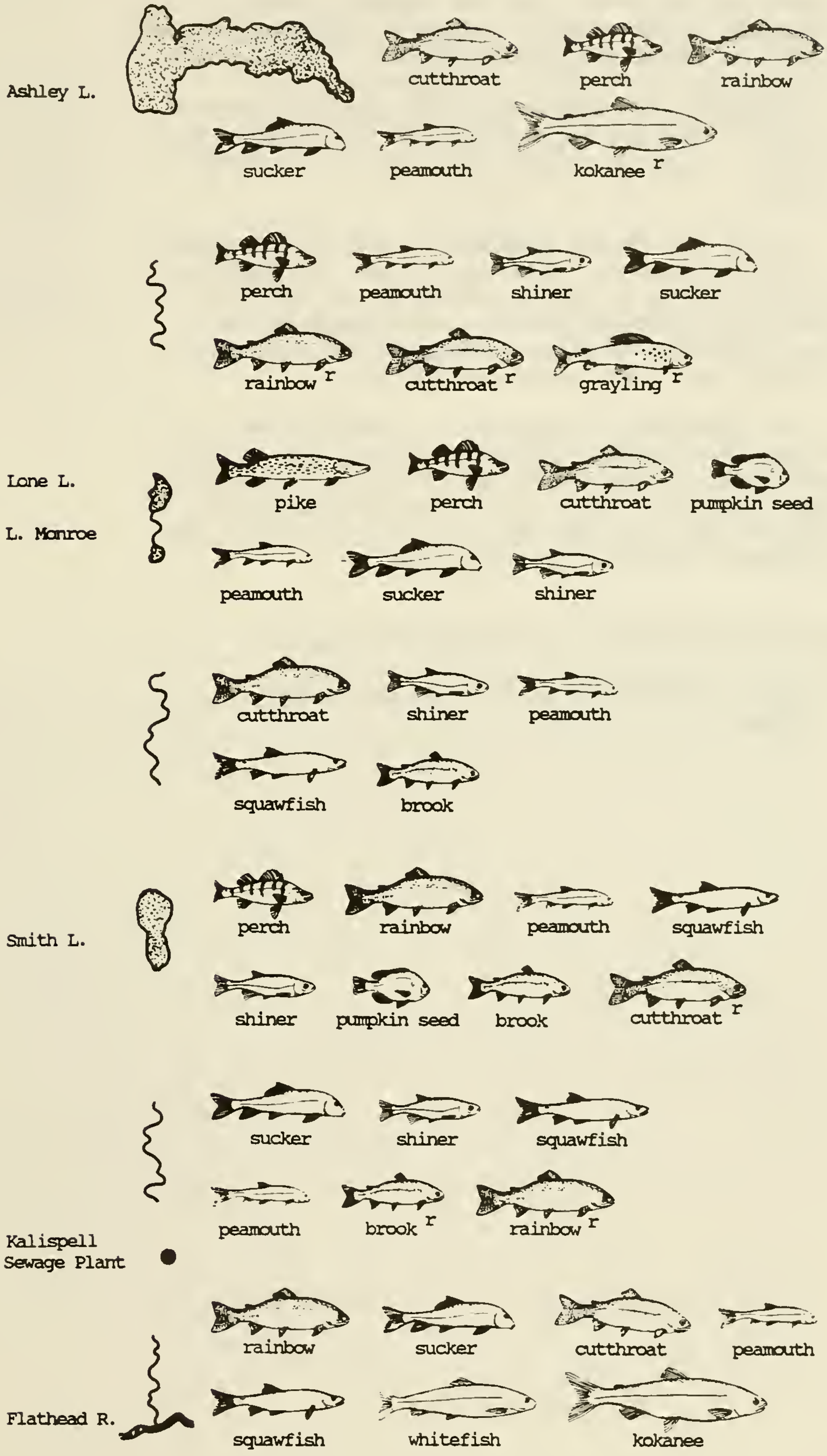
From Monroe Lake to the falls, the stream is dominated by rainbow trout, redside shiner, peamouth, squawfish and suckers. The falls is an effective barrier to fish passage.

From the falls to the Rogers Lake Road, rainbow and brook trout dominate the fish population. A 1985 population study along 1,475 feet in this section estimated a total 209 brook trout and 124 rainbow. This section is also used by rainbow trout from Smith Lake for spawning and rearing juveniles.

Smith Lake is gaining a reputation as one of the best perch fisheries in western Montana and is likely to become more popular. Ninety-five percent of the fish in Smith Lake are perch which range up to 12 inches. Other common Smith Lake fish include rainbow trout, mountain whitefish, yellow perch, peamouth, suckers, redside shiners, squawfish and pumpkinseed sunfish. Brook trout and cutthroat trout also occur in Smith Lake but are rare.

Below Smith Lake, Ashley Creek is dominated by fish such as suckers, peamouth, yellow perch, red shiners and squawfish. Warm water temperatures and

Figure 10. Generalized distribution of fish in Ashley Creek.



r = present but rare in this location

increased nutrients from the Kalispell sewage treatment plant stimulate algae and duckweed growth and favor these rough fish species. Rainbow and brook trout are rare in this stream section. Pumpkinseed are common above the sewage treatment plant. There are reports that kokanee salmon once spawned in lower Ashley Creek, but not for many years.

In the last decade a bypass channel was proposed around Smith Lake. This project was supposed to reduce warming of stream waters in the lake and favor fish species needing colder temperatures. Many potential problems were predicted for this project and it was never constructed.

Good streambank management is essential for maintaining healthy fish populations, but all the relationships are not known. Fisheries biologists must continue to work with streamside owners to better understand and enhance those factors which influence individual fish species.

For more information on fisheries contact:

* Montana Department of Fish, Wildlife and Parks

Ashley Creek Streambank Inventory Results

In 1987, representatives from three natural resource agencies and the city of Kalispell conducted a streambank inventory along all 44 miles of Ashley Creek. The information from this inventory has been compiled on air photos which are available at the Flathead Conservation District offices in Kalispell. Table 4 summarizes various streambank conditions found in this inventory.

Table 4--Streambank inventory results along Ashley Creek

	Number of sites	Feet
Eroding Banks	71	9875
Streambank Failures	57	4520
Bank Mass Wasting	24	1737
Unvegetated Non-eroding Banks	44	5941
Blanket Rock Riprap	15	645
Stream Channel Changes	5	3800
Irrigation Diversion Structures	8	
Car Bodies	4	
Fish Barriers	8	
Debris Jams	59	
Tires (50)	1	
Livestock Access Sites	46	
Drain or Ditch Entries	7	
Fences Across Stream	7	
Beaver Dams	1	

These streambank conditions total 26,000 feet or 11 percent of the stream length. This percentage is less than was found in similar inventories of the Whitefish, Stillwater, Bitterroot and Clark Fork Rivers. The main reason for this difference is the low-gradient and slow flow characteristics of Ashley Creek, making it relatively "tame" compared to other streams.

UNVEGETATED, TRAMPLED, ERODING BANKS

Eroding banks, Streambank Failures and Bank Mass Wasting sites were identified along over 22,000 feet of streambank. Over 5,900 additional feet were classified as Unvegetated, Non-eroding Banks.

Streambanks lose soil by erosion, mass wasting, and failure of banks. Vegetation is the single most important factor preventing streambank loss. Healthy root systems literally hold the banks together. Organic chemicals exuded by roots and released by organic decomposition help "glue" soil particles together. Plants also protect the soil surface from the erosive impact of raindrops. Most of the eroding streambank materials are dominated by silt with little sand except in localized areas.

MASS WASTING OF BANK MATERIALS INTO ASHLEY CREEK

Blanket Rock Riprap has been placed along only 600 feet of Ashley Creek streambanks. Riprap is used to protect banks from erosion. This small quantity reflects the low-gradient along most of the stream. Most riprap has been placed to protect bridge structures. Riprap is an appropriate streambank management tool when used properly. Most appropriate uses involve protection of expensive structures such as homes and bridges.

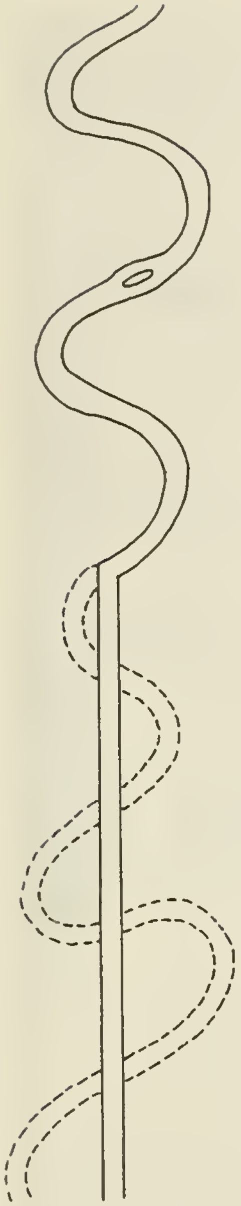
ROCK RIPRAP PROTECTING A BRIDGE

Riprap can be misused and can create problems, especially when it is applied along extensive stretches in an attempt to "lock in" the stream to a specific flow pattern. This prevents natural meander migration which all streams undergo. Accelerated erosion and deposition can occur both above and below such riprap projects. Improper installation is a common cause of riprap failures.

When riprap is used to protect bridge abutments it must not be placed in a manner which constricts the stream and accelerates velocity or erosion will also be accelerated. Riprap must be properly installed or it will be removed by the stream and the banks will once again be exposed to erosion.

The use of riprap has declined in recent years except for protection of bridge structures. This decline has resulted from increased costs and better understanding of hazards in widespread use.

ROCK RIPRAP PROTECTING A BANK FROM EROSION



STREAM CHANNEL STRAIGHTENING

Stream Channel Changes have occurred along approximately 3800 feet of Ashley Creek. At these sites, the stream has been straightened to remove meanders and provide more room for agriculture or urban development. Stream channel changes are risky undertakings and can have serious impacts both upstream and downstream. The meander pattern of a stream is a delicate balance in relation to gradient, materials, flow and other factors. Shortening the stream increases the gradient along that stretch. Increased erosion occurs throughout and immediately below the straightened stretch. Sediment from these areas of increased erosion is deposited downstream. This change in erosion and deposition alters the meander pattern for a substantial distance downstream.

Stream straightening also reduces floodwater storage capacity and may increase the severity of floods downstream. Stream channel changes are often the basis of legal disputes where one property owner is suffering from channel migration stimulated by his neighbor's stream modifications.

Only **4 car bodies** and **50 tires** were found along Ashley Creek. These were used in the past as riprap to help control bank erosion. Car bodies have been outlawed for streambank stabilization purposes and many were removed from streams after enactment of junk vehicle regulations in the 1970s. The effectiveness, suitability and legality of tires as riprap are currently under study in many parts of Montana.

Fish Barriers (4), **Beaver Dams** (1), **Fences** (7) and **Debris Jams** (59) all restrict movement along Ashley Creek. While fish barriers, debris jams and the beaver dam restrict fish migration, these features also improve habitat by creating pools of deeper water.

There were 46 **Livestock Access Sites** identified by inventory crews. These areas are characterized by little vegetation, compacted and bare soil, trampled banks and obvious animal wastes. Not included were less heavily impacted areas where livestock had access to the stream but banks were in relatively good condition.

Streambed composition is determined by the nature of the material through which the stream flows and also by the gradient. Stream gradient determines the size of material that can be transported. Because Ashley Creek flows through very silty materials and has a very shallow gradient, streambed materials are high in silt and low in gravel content for much of its length. A few areas with gravelly streambed conditions do occur, mainly in the upper drainage. Salmanoid spawning is restricted by this lack of gravelly streambed.

Relatively few irrigation diversion structures occur on Ashley Creek. Many water users currently have pump sites along the stream for sprinkler irrigation systems.

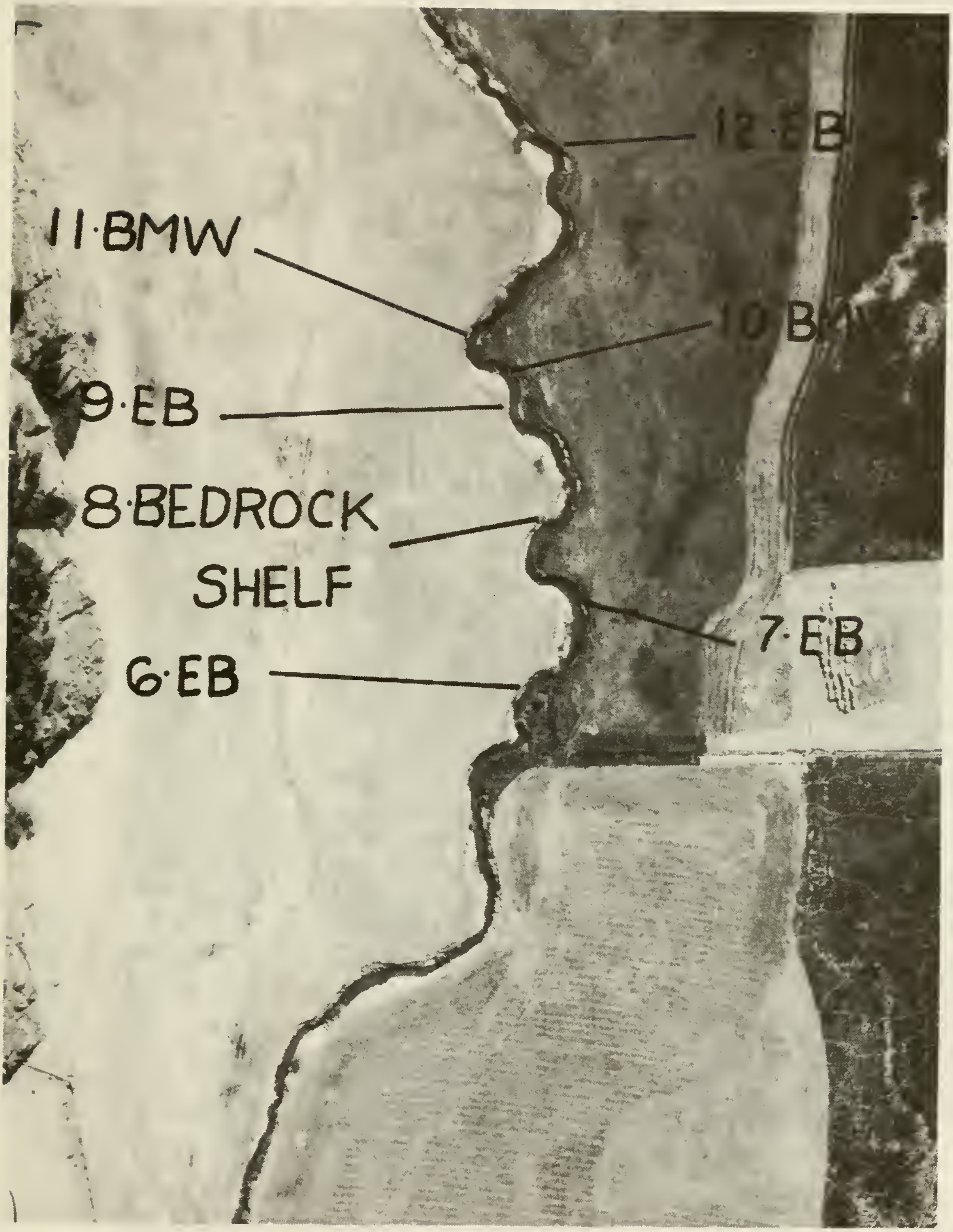
The Riparian Corridor

The riparian corridor of Ashley Creek has been altered by human activity along much of the stream. Under natural conditions, this corridor is a zone of intact, lush vegetation which acts as a buffer between the water and surrounding land uses. This corridor helps filter sediment and other pollutants before they reach the creek. It provides shade and cover for both aquatic and terrestrial animals. Degradation of the riparian corridor makes the creek more susceptible to pollution, streambank erosion, and other negative impacts.

Between Ashley Lake and Highway 2, the creek passes through mostly forested areas where the riparian corridor is healthy and dominated by native species. However, a few areas of private agricultural land occur in this section where the riparian corridor has been dramatically altered. These alterations include removal of the native vegetation, grazing along the stream, cultivation to within a few feet of the banks and stream channel straightening.

To improve the riparian corridor along this section, landowners should fence out livestock and establish buffer strips of vegetation along the stream. Other examples of methods for improving the riparian corridor are listed as BMPs in Appendix 4.

From Highway 2 near the Ashley Lake road to Kalispell, the creek passes through several ranching operations and numerous small private ownerships. The riparian corridor along portions of this stretch is relatively intact and provides an example of pre-white man conditions. However, along most of this stretch, the original shrub and tree-dominated vegetation has been removed or seriously altered. At some sites, livestock have overgrazed the banks and exposed bare soil to erosion. At other sites, crops are grown and



EXAMPLE AIR PHOTO FROM THE 1987 STREAMBANK INVENTORY
(AVAILABLE AT THE FLATHEAD CONSERVATION DISTRICT)

harvested almost to the creek itself. Corrals, pens, pastures and other inappropriate land uses encroach upon the riparian corridor with no buffer of dense vegetation. To improve the riparian corridor along this section, landowners could fence out livestock and establish buffer strips of vegetation along the stream. Other examples of methods to improve the riparian corridor are listed as BMPs in Appendix 4.

In the stream section through Kalispell, industry and development have encroached upon the riparian corridor. The original shrub and tree-dominated vegetation has been removed or seriously altered throughout most of this section. Vegetation is mowed to enhance its appearance. This reduces its effectiveness as a filter for pollutants, habitat for wildlife, and as a bank stabilization tool. Debris has been dumped in the corridor and allowed to wash downstream during high water. To improve the riparian corridor in this section, vegetation must be replaced or allowed to grow freely along a buffer strip 15-30 feet wide.

From Kalispell to Snowline Lane, the riparian corridor has been constricted by agricultural and urban uses. Corridor alterations include removal of the native vegetation, grazing along the streambanks, and cultivation to within a few feet of the stream. To improve the riparian corridor along this section, landowners could fence out livestock and establish buffer strips of vegetation.

Summary and Recommendations

The 1987 Streambank Inventory provides an excellent picture of current conditions on Ashley Creek. The location and extent of each streambank feature are documented for future reference. The main problem identified by this inventory is streambank erosion in several forms. Also, the riparian corridor has been severely altered and constricted along much of the stream. Revegetation efforts are needed to reduce erosion and regain the benefits of a healthy, intact riparian corridor.

OFFSTREAM NONPOINT POLLUTION ON ASHLEY CREEK

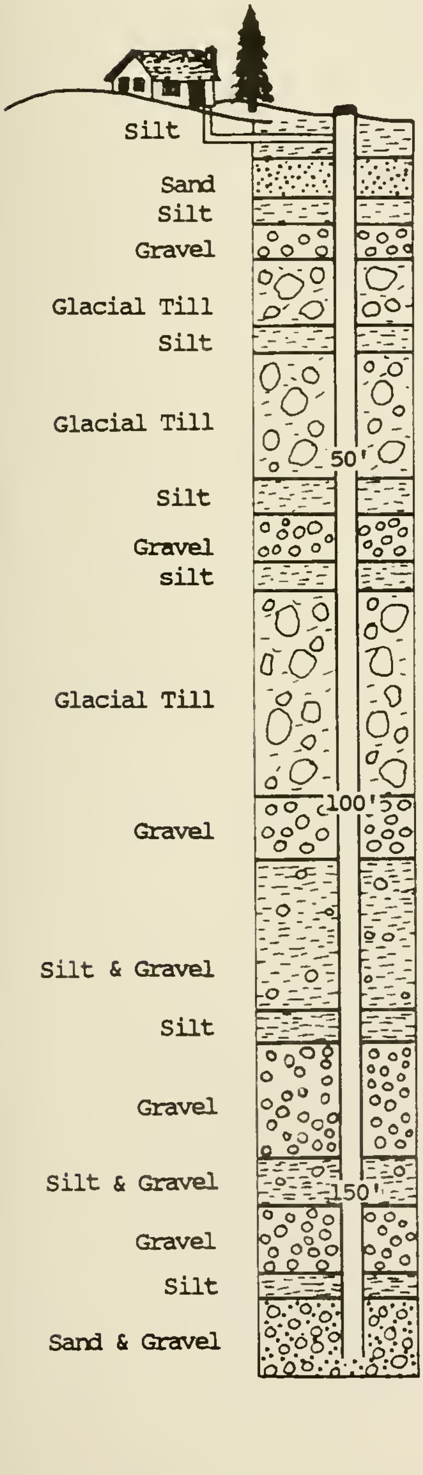


Figure 11. Typical valley well log

Nonpoint pollution includes a wide variety of scattered, usually small sources which individually are of minor consequence but which can add up to big problems across a large area. In the simplest terms, nonpoint pollution is the pollution which doesn't come out of a pipe in large quantities. Nonpoint pollution sources include logging roads, pastures and urban runoff. Scattered, low volume, "point" sources such as leaking underground storage tanks and septic tank drainfields are also categorized as nonpoint pollution.

The Federal Water Protection Control Act was amended in 1972 to include a section on nonpoint pollution (Section 208). In Montana, local Conservation Districts were given Section 208 responsibilities to inventory and address nonpoint pollution concerns on a local level. Many districts have completed general inventories of local nonpoint sources and have contributed to designing "Best Management Practices" for addressing these sources. Conservation Districts also accepted responsibility for working with landowners at the local level to solve and prevent nonpoint pollution problems. This report represents one way the Flathead Conservation District is working to meet these goals.

Limited funds are available to help solve nonpoint pollution problems. Some of these funding sources include the Rural Clean Water Program, the Watershed Program, the Small Reclamation Projects Act and a special section of the 208 Nonpoint Pollution Section of the Federal Water Pollution Control Act.

Groundwater Resources

Nonpoint pollution affects both stream water quality (discussed in previous sections) and groundwater quality. Groundwater quality is classified by the Montana Water Quality Bureau in a similar manner to surface waters. Groundwater resources in the Ashley Creek watershed have received limited study but enough is known to provide a brief overview.

Much of the watershed is underlain by bedrock at less than 50 feet and often shallower. Bedrock wells usually produce less than wells in the unconsolidated glacial and stream materials of the central valley. Bedrock wells in the Ashley watershed are usually more than 200 feet deep and produce 10 to 20 gallons per minute or less. Many bedrock wells in the watershed are over 500 feet deep and some are over 1000 feet. Limestone in the eastern watershed seems to be the most productive of the bedrock sources.

Wells in the main valley area extract most water from glacial deposits. These wells are usually shallower and more productive than bedrock wells. Figure 11 illustrates a valley well log from just west of Kalispell. This log shows how valley deposits can vary with depth. Gravelly and sandy water-bearing layers are sandwiched between relatively impermeable silts and clays. Well drillers hope to encounter one of these gravelly layers. Despite their usual superiority over bedrock sites, valley sediments can also have dry wells. In many cases, water is present in silty and clayey layers but cannot be extracted in sufficient quantities due to very slow permeability. Despite these problems, occasional wells produce abundant, clean water from the 50-100 foot zone.

In the lower Ashley Creek watershed, groundwater flows in an easterly and southeasterly direction throughout the valley sediments. Flow in the upper watershed is towards and along the stream valleys. Flow rates are very slow in both the bedrock and valley sediment areas except where sandy and gravelly layers are present. Depth to groundwater varies considerably. Most valley sites have multiple groundwater tables. In much of the Kalispell area and valley bottom to the west, the first groundwater is encountered at 10 to 30 feet. This groundwater table is usually associated with surface water flows. Water moves from the stream into adjacent groundwater zones or groundwater flows into the stream. Levels and flow directions may fluctuate considerably throughout the year. These shallow water tables are very susceptible to contamination because of their proximity to the surface. Soil permeability in the lower Ashley Creek watershed is slow but may still allow migration of contaminants into shallow water tables.

Deeper groundwater tables are less uniform and predictable. Many are under artesian pressure. These deeper water layers mostly occur in discontinuous lenses of coarse sands and gravel. While some water may occur in silt and clay layers, it is difficult to extract due to slow permeability. The slow permeability of silt and clay layers is beneficial as well as detrimental because it reduces vertical migration between groundwater layers. This decreases the potential for contaminants to migrate between groundwater layers or from the surface.

Table 5 and Figure 12 illustrate major sources of nonpoint pollution in the Ashley Creek Watershed. Instead of setting strict regulatory standards for nonpoint pollution sources, conservation districts have developed the concept of "Best Management Practices". These are recommended land management techniques which should create less nonpoint pollution than other methods. Appendix 4 lists examples of Best Management Practices for forestry, agriculture and urban development. The following sections discuss nonpoint pollution according to major land uses.

Forestry

Sediment is the main form of pollution from timber harvest and related activities. It comes from roads, log loading areas, scarified slopes, burned sites and other areas. Sediment also comes from gravel pits used for road building materials, from airborne particulate along haul roads and from wood processing plants.

Roads are the main source of sediment in forested areas. Minimizing the number of roads will have substantial effects on sediment pollution. Roads should be located to avoid riparian corridors, highly erosive soils and steep slopes. Minimizing stream-crossings, installing waterbars on skid trails and reseeding skid trails and roadcuts will all reduce sediment. Buffer strips 15 to 30 feet wide of undisturbed vegetation should be left along lakes and streams. Sediment traps can also be installed to prevent eroded soil from reaching the stream. Harvest activities can be planned for fall when soils are driest and precipitation lowest, or for winter when snow protects the soil surface.

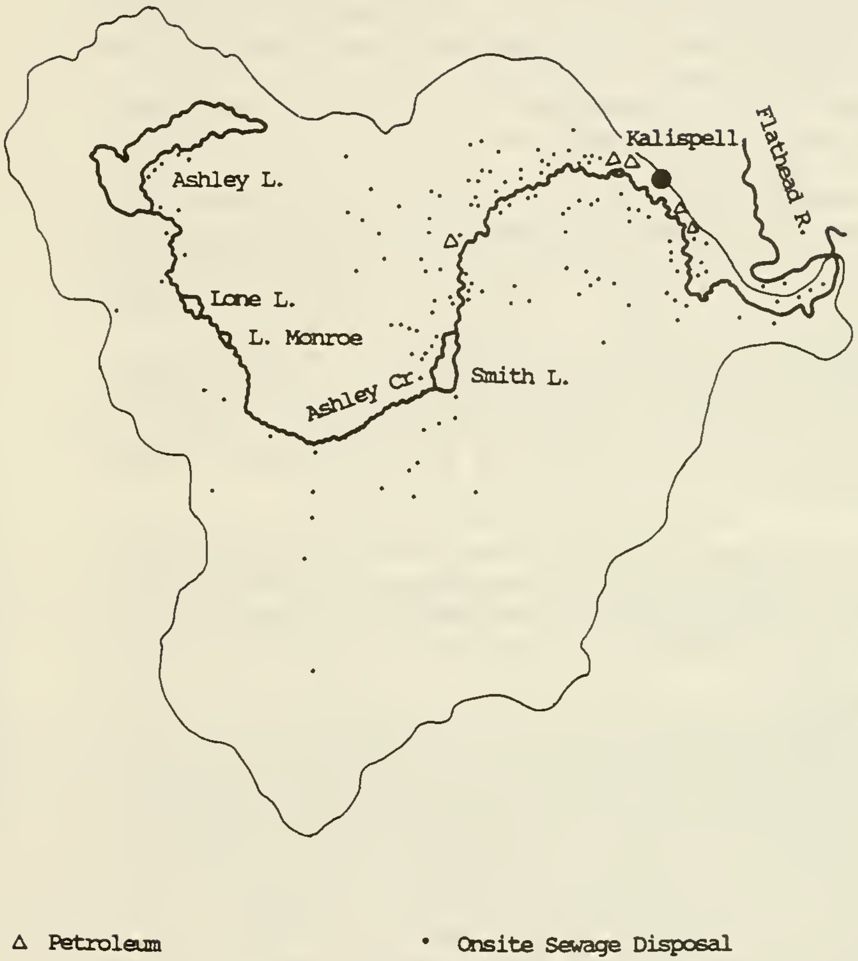
Accidental spills of petroleum products from storage tanks and during refueling can be significant depending on the size of spill, proximity to the creek, soil characteristics, and other factors. Foresters can help minimize these problems by storing fuel and equipment on impermeable soils away from streams and drainages.

These are only a few examples of practices for reducing nonpoint pollution in forested areas. Further information is available in Appendix 4 or from the Flathead Conservation District and State Forestry Division.

Table 5--Major sources of nonpoint pollution in the Ashley Creek watershed

SOURCE	POLLUTANTS
FORESTRY	Sediment from roads, landings, scarified and burned areas
	Petroleum products from storage tanks, refueling equipment, and accidental spills
INDUSTRY	Sediment from bare soil areas including roads, maintenance yards and other sites
	Chemical runoff including pesticides, phenols, heavy metals, cleaning solvents, animal wastes, and others
	Petroleum products from storage tanks, refueling equipment, and accidental spills
AGRICULTURE	Sediment from bare soil areas such as cultivated fields, heavily grazed pastures
	Chemical runoff including pesticides, fertilizer, cleaning solvents, animal wastes, and others
	Petroleum products from storage tanks, refueling equipment, and accidental spills
URBAN AREAS	Sediment from bare soil areas including construction sites, unvegetated roadcuts, and other locations
	Chemical runoff including pesticides, phenols, heavy metals, cleaning solvents, road salts, and others
	Petroleum products from storage tanks, refueling equipment, and accidental spills
	Nutrients and pathogenic organisms from septic tank drainfields

Figure 12. Sources of nonpoint pollution in the Ashley Watershed



Agriculture

Agriculture is another source of sediment which comes from cultivated fields, heavily-used livestock areas, roads, and other sites where plant cover is inadequate to prevent erosion. These sources can be eliminated or mitigated by using special cropping systems such as minimum tillage and farming on the contour. Grassed waterways and sediment traps can be used to prevent sediment that is eroded from fields from reaching the stream. Proper grazing management will leave sufficient plant cover to prevent erosion.

Chemical runoff may also occur in agricultural areas and may include pesticides, fertilizer, animal wastes or other organic matter and petroleum products from leaks and spills. These sources can be reduced by proper handling and storage of chemicals and petroleum products. Animal wastes and other organic matter should be kept away from the riparian corridor and side drainages leading into the stream. Livestock should be excluded from streambanks and the riparian corridor.

These are only a few examples of practices for reducing nonpoint pollution in agricultural areas. Further information is available in Appendix 4 or from the Flathead Conservation District.

Industry

Nonpoint pollutants from industrial sources in the Ashley Creek watershed include sediment, chemical runoff and petroleum products. Sediment is eroded from bare soil areas such as roads, maintenance yards, storage yards and other sites. Keeping these areas well-vegetated is the most effective way to reduce sediment. Grassed waterways and sediment traps can be used to prevent sediment that is eroded from reaching the stream.

Chemical runoff includes pesticides, heavy metals, phenols, cleaning solvents, animal wastes, organic matter petroleum products and others. Chemicals and petroleum products are often washed from equipment or facilities and may run off into stream channels or percolate to the groundwater.

These sources can be reduced by proper handling and storage of chemicals and petroleum products and by practicing more conservative use. Storage facilities should be monitored on a regular basis. Barriers to the movement of these wastes can also be constructed. These barriers may include grassed waterways, buffer strips and sediment traps which are periodically cleaned. Maintaining a wide and healthy riparian corridor will provide an added barrier to these substances reaching the stream. Barriers to prevent infiltration of chemicals to the groundwater may include clay and plastic underlinings and berms. These are only a few examples of practices for reducing nonpoint pollution in industrial areas. Further information is available in Appendix 4 or from the Flathead Conservation District and local health department.

Urban Areas

Sediment is also a common nonpoint pollutant in urban areas, which we will consider to include rural homesites. Sediment is eroded from bare soil areas such as road and construction sites. The most effective way to control this erosion is by revegetation.

Construction activities should attempt to minimize disturbance and immediately reseed bare soil. Temporary mulching of bare areas and adjacent drainages will also help.

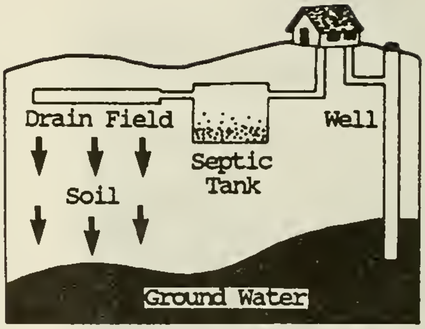
CONSTRUCTION ACTIVITIES AFFECT WATER QUALITY IN MANY WAYS

Chemical runoff in urban areas includes pesticides, fertilizer, road salts, cleaning solvents, petroleum products, and many other compounds. The Kalispell storm drain system collects water from a large area and then pipes that water directly into Ashley Creek. While the water from this drainage system usually contains only small quantities of harmful pollutants, occasionally large inputs can occur. These larger inputs include petroleum products from accidental spills such as auto accidents. Individual residents who do not understand the relationship to the creek may occasionally use storm drains to dispose of hazardous materials. Problems of chemical runoff can be minimized by proper storage and conservative use of all chemicals. Communities can help prevent improper disposal of chemicals by providing information and locations for proper disposal.

In recent years, petroleum products have become a major source of water pollution. Numerous incidents of water contamination by petroleum have occurred across the state and country. The U.S. Environmental Protection Agency predicts that half of the underground petroleum storage tanks in the country are currently leaking. This prediction has resulted in state and federal LUST programs to inventory and repair Leaking Underground Storage Tanks. The Montana Water Quality Bureau recently began a registration program for all petroleum and other products held in below-ground tanks. This program requires special construction, installation and monitoring methods for all storage tanks.

The only recent, documented case of petroleum contamination in the Ashley Creek watershed was at a convenience store across from the Batavia School. In 1986 a small quantity of diesel fuel was spilled. Contaminated soil was collected and removed to the county landfill. Cleanup crews also encountered gasoline and an empty, abandoned tank from a 1950s gas station. Shallow test wells were installed around the store and monitored for petroleum products. All wells north of the highway showed contamination in trace amounts. One well was installed south of the highway and did not show contamination. The nearby Batavia School well is 150 to 200 feet deep and has not been contaminated. There is not a great concern for it becoming contaminated since the water-bearing layers are deep and the upper soil materials are relatively impervious.

There are between 750 and 1250 septic tank drainfields or other on-site sewage disposal systems in the Ashley watershed. About 300 of these are within one-half mile of the creek. Drainfields release septic tank effluent into the biologically active surface soil layer where it is decomposed by soil micro-organisms. Most Ashley Creek soils have tremendous nutrient treatment and retention capabilities. The majority of systems are sited in silty soils with relatively slow permeability. Some systems are sited in sandy and gravelly soils that have rapid permeability. One problem with local systems is where the soil materials contain too much silt and clay so that effluent will not move into and through the soil fast enough. In these cases the effluent may surface or back up into the residence. At the other extreme are sandy and gravelly soils where sewage effluent moves through the soil too fast for adequate treatment. This untreated effluent can contaminate ground or surface waters. Since local sandy soils are underlain by more impermeable soils, effluent will usually migrate vertically down to the impermeable zone and then move laterally. Development intensities and septic system designs must consider the soil capability to treat waste or water pollution may occur. The Flathead County Health Department has not recorded any major incidents of water pollution in the Ashley watershed from on-site sewage systems.



INDIVIDUAL ON-SITE SEWAGE TREATMENT SYSTEM

"Natural" Nonpoint Pollution

"Natural" sources of nonpoint pollution may include organic matter from areas with organic-rich soils and sulfur from mineral and organic deposits. In the Ashley Creek watershed, large organic deposits occur which influence water quality, primarily near Smith Lake.

Offensive aromas may render water unusable even when it's safe to drink. While many substances cause foul smells, sulfur is the most common. The human nose is extremely sensitive to certain sulfur compounds, especially hydrogen sulfide (H2S). Wells in the Kila area which draw water from the upper 100 feet often have enough sulphur to be offensive. The source of this sulphur is most likely the abundant organic deposits of the immediate area and not a zone of sulphur mineralization related to the bedrock. Simple filtration systems can reduce sulphur content to acceptable levels.

Some natural sources of nonpoint pollution can be addressed, such as a zone of highly erodible soils. However, sources such as the Smith Lake organic deposits are not easily "fixed" by water quality management, and it may by we just have to live with them.

VIEW LOOKING SOUTH WHERE ASHLEY CREEK LEAVES SMITH LAKE

WORKING TOGETHER FOR A HEALTHY CREEK

Project Ideas for Streambank Improvement

In this report we have provided information about streambank conditions and nonpoint pollution in the Ashley Creek watershed. The next question we hope you have is, "Where do we go from here and how can I help?".

Good streambank management benefits everyone. With this in mind, it's only proper that "everyone" be able to make a contribution if they choose. This section presents some ideas for projects to improve streambank management in your area. This discussion does not include all possibilities, of course. We hope that individuals and groups will help us to think of new and different ways to address these issues.

What To Do: Educate

Education about streambank management is an essential contribution that can be made by any individual, and is not restricted to the classroom. You can use many situations as opportunities to educate friends or neighbors about streambank management.

Talk to neighbor landowners who are experiencing streambank erosion or other problems on their property. Discuss these issues at PTA, 4-H and Grange meetings, or at cocktail parties, football games and other gatherings. You can talk about specific sites and projects or just let landowners know where they can get technical assistance.

One-fourth of Ashley Creek streambanks are owned and used by small landowners with residences, some of whom may be unfamiliar with the principles of streambank management.

What To Do: Get Involved

Many streamside landowners will simply take it upon themselves to clean up their own properties. Groups of landowners may undertake projects together. Service organizations, civic groups, and schools will often choose projects and sites based on pre-existing associations with individual land owners. It is important that school groups choose nearby sites which can be easily used for education both now and in the future.

Who to Involve

To plan any project it's essential to maintain a cooperative atmosphere among all parties. Important questions to ask from the project's beginning include:

1) Who is presently affected by the area or problem?

2) Who will be affected by the solution?

3) Who can contribute positively to the project?

Most of the Ashley Creek streambanks are privately owned, and are used primarily for agriculture and private housing. These groups will therefore be directly affected by any streambank projects and should be included in all aspects of planning and implementation.

Many government organizations have regulatory authority on Montana streams. Care must be taken to coordinate activities with these regulators, who are also excellent sources of technical assistance. The Flathead Conservation District or USDA Soil Conservation Service are good places to begin your inquiries about projects.

School classes, community youth organizations and community groups are often eager to assist in a project to improve the community, and can provide much-needed manpower and enthusiasm. These groups can do such things as "adopt a streambank", where they take part in fencing, revegetating, cleaning, and also monitoring the site's recovery over time. This exercise is especially good for youth groups, as it gives the student, cub scout, or future farmer a direct interest in one streambank which can eventually develop into a concern for all streams. Participants can point to their efforts with pride for years to come.

What Action to Take: Problems & Solutions

Many agencies, especially the Flathead Conservation District, have experts available to give advice on streambank management. A number of streambank problems are so common there are "standard specifications" available for their remedy. In this section we will illustrate a few of the most common streambank problems and their remedies.

Streambank Erosion

The most common problem noted along Ashley Creek and many other streams is bank erosion. This has often resulted from unrestricted access to the stream by livestock. Erosion can be reduced or eliminated by maintaining a 15 to 30 foot buffer strip of lush, diverse vegetation along each bank. This vegetation holds the banks together and filters out sediment and other pollutants before they enter the stream. Eroding banks can be revitalized by a very simple and straightforward series of actions.

Step 1: Fence livestock

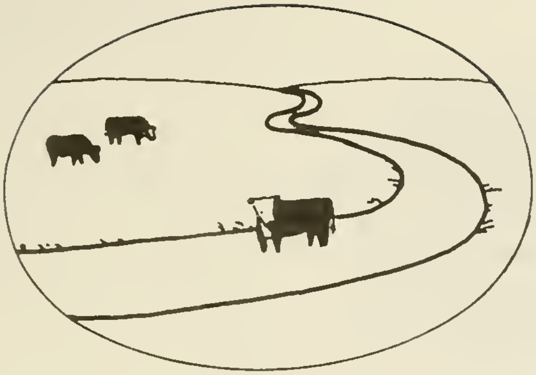
Livestock are a primary source of erosion along streams. Livestock consume the leaves and stems of streamside vegetation, then trample and kill the roots. Continued trampling causes the soil's organic matter to oxidize. This lost organic matter formerly helped to hold the soil together and improve infiltration. When it's lost, soil particles are more susceptible to being dislodged and transported. Trampling also breaks down the soil structure from "clods" which are too large to transport into individual sand, silt and clay particles which are easily eroded. Trampling may also compact soil making it difficult for plants to re-establish themselves. Compaction usually favors weeds over native or other desirable species.

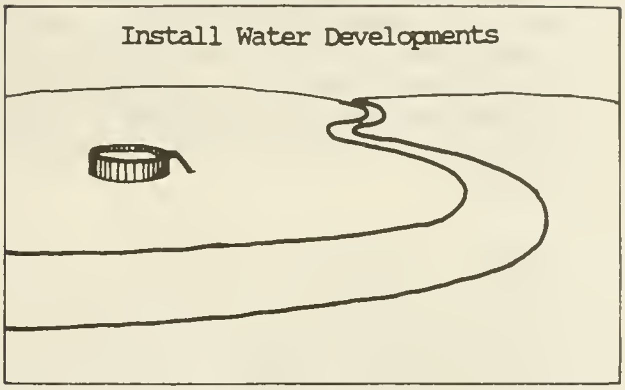
In recent years, thousands of miles of streambanks have been fenced in order to protect them from cattle. To meet the needs of livestock after fencing, off-stream stockwater developments are installed. These usually consist of a tank or trough with a pipe carrying water from the stream. Water is supplied by pump or by gravity-feed with a pipe running upstream to deliver water under sufficient pressure.

Step 2: Revegetate

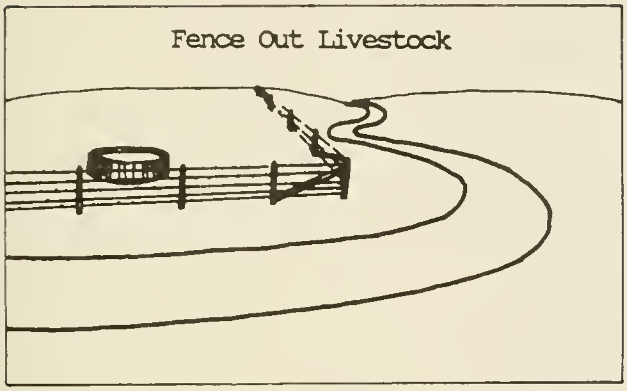
When livestock use has been eliminated, streambank revegetation can proceed. One method of revegetation is to simply use local plant materials. These local plants are already adapted to the site and may be preferred if the project goals include a concern for maintaining native species. Willows are the most common species used for this purpose. Healthy willow shoots are simply cut at an angle and placed in water to form roots. Growth hormones can be added to stimulate rooting. When roots are evident, these sprigs are planted in holes poked with a blunt object. The entire process is simple and can be accomplished by anyone.

IMPROVING STREAMBANK MANAGEMENT

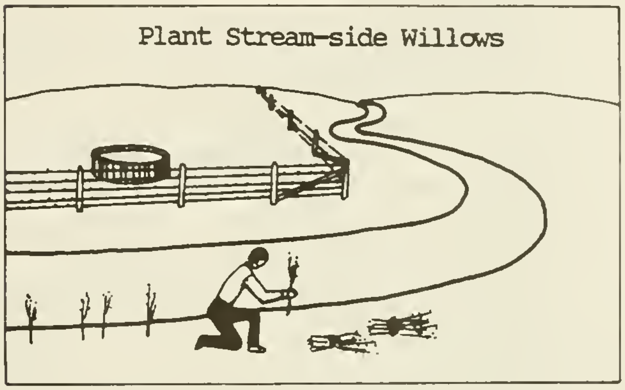




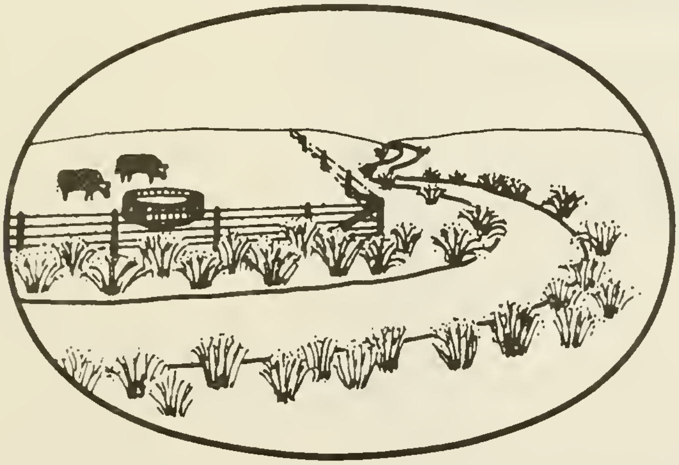
Install Water Developments



Fence Out Livestock



Plant Stream-side Willows



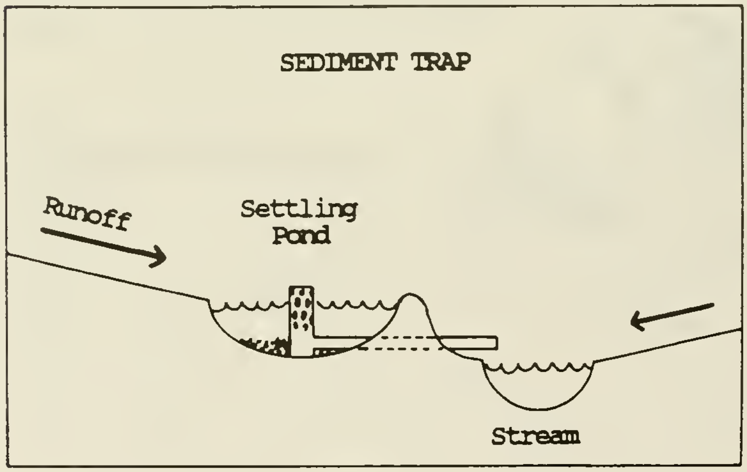
WELL MANAGED STREAMBANK

Non-native plant species can also be used successfully for revegetation if they are carefully chosen to fit the site. These are available through many commercial sources. Contact the Flathead Conservation District for information about species selection. Some native species may also be available from commercial and government sources for special projects. Appendix 7 contains information on species characteristics and selection.

Labor is usually the biggest expense in revegetation. This is the ideal opportunity for volunteer efforts, particularly with groups such as schools, scouts, 4-H, future farmers and others. But don't always restrict participation to a specific organization. Publicize your activities and invite general public involvement.

Sedimentation

Another common problem is sediment and runoff entering the stream from roads, logging operations, corrals, feedlots, tilled fields, or other areas. Most of these situations can be remedied with improved water management. Buffer strips and grassed waterways of intact vegetation can be established or widened along the stream and along swales which empty into the creek. Grassed waterways are simply a permanent grass cover maintained along a drainage. This prevents the erosion that would occur if the drainage were cultivated or heavily grazed. Grassed waterways hold the soil together and also filter out sediment and other pollutants.



Sediment traps are constructed near the stream to intercept sediment. These traps are often a simple depression or pit where the water velocity is slowed so that sediment settles out before reaching the stream. The sediment which accumulates in these traps is removed periodically. This sediment is spread and revegetated at a spot where it will not be subject to future erosion. In agricultural areas, the sediment can be returned to the fields from which it eroded.

Working Together

Each project must be a cooperative blend of technical advice, landowner goals, community interests, manpower, and funds. There is often more than one solution, and a range of options and contingency plans must therefore be developed. In all efforts, maintain a sense of humor and realize it takes time to see results. Despite frustrations and setbacks, a completed streambank protection project can be a rewarding experience that reaps benefits for many years. Table 6 lists some of the most obvious projects needed along Ashley Creek.

Table 6. Project Needs along Ashley Creek

Replacement of the Ashley Creek control structure

Removal of debris from the stream where the removal will not cause excessive siltation

Removal of car bodies and tires where the removal will not cause excessive siltation

Fencing streambanks to prevent livestock access. Provisions for off-stream water developments must then be made.

Completion of a soil survey for the entire watershed

Revegetation of streambanks

Reclamation of the riparian corridor

Inventory of existing onsite septic systems

Inventory of Groundwater Resources

SUMMARY

To improve stream quality on Ashley Creek, the banks must be revegetated and erosion must be reduced. Education is needed to prevent stream alterations and control nonpoint pollution sources. Two of the most serious water quality problems are the Kalispell sewage treatment plant and the presence of livestock along the stream. These problems can be solved by improving treatment and fencing livestock out of the riparian corridor. Debris such as leaves, garbage,and other items should not be dumped along streambanks. With proper management, Ashley Creek will continue to be a valuable resource.

WELL-VEGETATED STREAMBANKS NEAR DEMERVILLE ROAD

APPENDICES

APPENDIX 1 : Sources of Further Information

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APPENDIX 2--GLOSSARY OF TERMS

ACRE FEET - The amount of water needed to cover 1 acre 1 foot deep; 43,560 cubic feet; 325,900 gallons; approximately one year's water supply for a family of five; will irrigate 0.25 to 1.0 acres in Montana.

ALLUVIUM - Unconsolidated materials deposited by running water including sand, silt, clay, gravel, cobbles and mixtures of these. Running water sorts materials by size class and rounds the edges of rocks.

ARGILLITE - A sedimentary rock that started out as mud deposited on a lake bed or sea floor and was hardened into mudstone and then further into argillite. A very hard rock.

BENEFICIAL USE - A use of water for a purpose which benefits the general community.

BLANKET ROCK RIPRAP - Large diameter rocks (2-5 ft) placed along streambanks to prevent erosion.

BANK MASS WASTING - Movement of bank soil materials into the creek by mass wasting processes which involves large chunks of material slumping, sliding or flowing.

BEST MANAGEMENT PRACTICES - Specific land management practices or activities which are recommended to produce the least nonpoint pollution and other problems.

BOD (Biological Oxygen Demand) - The amount of oxygen needed by micro-organisms to decompose a given amount of organic matter, also referred to as Chemical Oxygen Demand (COD).

CFS (CUBIC FEET PER SECOND) - discharge from a flume 1 foot wide by 1 foot high flowing at 1 foot per second; will support an average 80 acres of sprinkler irrigation; will cover 1 acre 1 inch deep in 1 hour; is equal to 40 miners inches.

CLAY - mineral soil particles less than .002 mm in diameter which take more than 2 hours to settle out of still water. Clay has a very high nutrient retention capacity. Clay also has a very high water holding capacity but it "holds" the water so tightly it is difficult to extract. Clay particles are the "glue" which hold sand and silt together in most soils.

DEBRIS JAM - Sites where debris blocks the stream, impairing but not preventing flow and fish passage.

FECAL COLIFORM - Bacteria which grow in the intestines of warm-blooded animals and are used as indicators of sewage pollution or animal wastes.

GLACIAL TILL - The material transported within and beneath glaciers; a heterogeneous mixture of sand, silt, clay, rocks and boulders.

GLACIAL OUTWASH - The deposits of glacial meltwaters. Sorted, well-rounded, sands, gravels and cobbles.

GRADIENT (STREAM GRADIENT) - The steepness of a stream, usually presented as the drop in elevation per mile of stream.

HEADCUT - A point of active erosion created by a change in velocity, gradient, or other associated property. Appears as riffle or small waterfall which migrates upstream. Headcuts are stimulated by human activities.

KAME TERRACE - A terrace deposited by glacial meltwaters flowing between the glacier and a higher canyon wall, valley side or lateral moraine. Usually appears as a linear, horizontal feature above the current valley floor.

LIMESTONE - A sedimentary rock dominated by calcium carbonate which was concentrated by micro-organisms or shellfish, deposited in ancient seas, and then turned into rock.

MORAINE (GLACIAL MORAINE) - A glacial deposit of materials carried within or beneath glacial ice (till). Usually an undulating topography at the end or sides of former glaciers.

NONPOINT POLLUTION - Nonpoint pollution includes a wide variety of scattered, usually small sources which individually are of minor consequence but which can add up to big problems across a large area. In the simplest terms, nonpoint pollution is the pollution which doesn't come out of a pipe in large quantities. Nonpoint pollution sources include logging roads, pastures, and urban runoff. Scattered, low volume, "point" sources such as leaking underground storage tanks and septic tank drainfields are also categorized as nonpoint pollution.

pH - The acidity or alkalinity as measured on the pH scale where 7 is neutral, larger numbers are more alkaline and smaller numbers more acid. The pH of streams is usually near neutral, with some exceptions.

QUARTZITE - A sedimentary rock consisting of sand which has been hardened into sandstone and further hardened into quartzite.

RIPARIAN - Riparian refers to the moisture-influenced ecosystems which border lakes, streams and other wet areas. These sites act as buffer zones between aquatic and terestrial habitats. The riparian corridor provides shade and cover for both aquatic and terrestrial animals. Degradation of the riparian corridor makes the creek more susceptible to pollution, streambank erosion and other negative impacts.

RIPRAP - Materials, such as large rocks, placed along a stream or lake to prevent erosion.

SAND - Particles between between 2 mm and .04 mm in diameter which settle out of still water in 40 seconds or less. Sandy soils have the same low nutrient and water retention capacities as rocky soils. They also have rapid permeabilities which allow fast migration of drainfield effluent or other pollutants. Individual sand particles do not bind together into "clods" as do clay particles. They may often occur as individual grains.

SILT - Particles between .04 and .002 mm in diameter which settle out of still water in between 40 seconds and 2 hours. Silty soils have the highest nutrient and water holding capacities, as much as 10 times that of sandy soils.

STREAMBANK FAILURE - Small-scale bank mass wasting.

STREAM CHANNEL CHANGES - Portions of the stream that have been straightened, realigned, shortened, encroached upon by roads and otherwise altered substantially by man.

TERTIARY - A period of geologic time starting about 60 million years ago, when the Rocky Mountains began to be uplifted, and ending about 3 million years ago with the start of the ice age.

TSS (Total Suspended Solids) - Total suspended solids (TSS) are the sediments carried in suspension by water. TSS reduce light penetration, increase temperatures and cover spawning gravels. Concentrations above 90 mg/l may harm fish directly.

APPENDIX 3: COMPLETE STREAM INVENTORY DATA
Ashley Creek, Montana

	Feet	Miles	%	Number of sites
Stream Channel Changes	3800	0.7	2	5
Blanket Rock Riprap	645	0.1	<1	15
Eroding Banks	9875	4.0	4	71
Streambank Failures	4520	0.9	2	57
Bank Mass Wasting	1737	0.3	1	24
Unvegetated Non-eroding Banks	5941	1.1	3	44
Total	26518	7.1	11	
Total Stream Length	234245	44.3	100	

Other Notations:

Irrigation Diversion Structures	8
Car Bodies	4
Fish Barriers	8
Debris Jams	59
Tires (1 site)	50
Livestock Access Sites	46
Drain or Ditch Entries	7
Fences across the stream	7
Beaver Dams	1

Ashley Creek Stream Inventory Results Compared With Other Stream Inventories

	Ashley Creek	Bitterroot	Clark Fork
Stream Channel Changes	2	2	5
Blanket Rock Riprap	<1	9	11
Eroding Banks	4	10	4
Streambank Failures	2		
Bank Mass Wasting	1		8
Unvegetated Noneroding Banks	3		
Total	11	>21	>28

APPENDIX 4: EXAMPLE BEST MANAGEMENT PRACTICES

Road Location

1. Minimize the number of roads constructed in a watershed through comprehensive road planning, recognizing intermingled ownership and foreseeable future uses. Use existing roads where practical.

2. Fit the road to the topography. Locate roads on natural benches and stable soil types to minimize the area of road disturbance.

3. Locate roads on well-drained soils and rock formations that tend to dip into the slope. Avoid slide-prone areas characterized by seeps, steep slopes, highly weathered bedrock, clay beds, concave slopes, hummocky topography, and rock layers that dip parallel to the slope.

4. Avoid high erosion hazard sites, such as steep narrow canyons, slide areas, slumps, swamps, wet meadows, or natural drainage channels. Where there is potential for material to enter a stream, obtain approval of the Conservation District and/or the Water Quality Bureau under applicable laws (i.e., 310 Permit, Turbidity Authorization).

5. Locate roads a safe distance from streams when roads are running parallel to stream channels. Provide an adequate SMZ in order to catch sediment and prevent its entry into the stream.

6. Minimize the number of stream crossings.

7. Cross streams at right angles to the main channel if practical.

8. Choose a stable stream crossing site and adjust the road grade to reach the site if possible.

9. Avoid unimproved stream crossings. When a culvert or bridge is not feasible, locate drive-throughs on a stable, rocky portion of the stream channel.

10. A 310 permit (Natural Streambed and Land Preservation Act of 1975) is required before disturbance is allowed within the area between the normal high water mark of perennial streams.

11. Avoid long, sustained steep road grades. Where unavoidable, establish effective water bars and sediment diversions.

12. Vary road grades to reduce concentrated flow in road drainage ditches and culverts and to reduce erosion on cut and fill slopes and road surface.

13. When locating roads, provide access to suitable log landing areas (flatter, well drained) in order to reduce soil disturbance.

Road Design

1. Incorporate preventive action into transportation plans. Minimize disturbance. Use available information to help identify erodible soils, unstable areas, and road surface materials.
2. Plan roads to the minimum standard necessary to accommodate anticipated use and equipment. When using existing roads, avoid reconstruction unless absolutely necessary. The need for higher standard roads can be alleviated through better road use management.

3. Construct cut and fill slopes at stable angles.

4. Use plans that balance cuts and fills or use full bench construction (no fill slope) where stable fill construction is not possible. Haul excess material to a safe disposal site and include these waste areas in soil stabilization planning for the road.

5. Contour and roll road grades for minimal disruption of drainage patterns.

Road Drainage

1. Design water crossing structures at points where it is necessary to cross stream courses. Provide for adequate fish passage, minimum impact on water quality, and at a minimum, the 25 year frequency runoff. Get a 310 permit for perennial stream crossings.

2. Install culverts to conform to the natural stream bed and slope. Place culverts slightly below normal stream grade to avoid culvert outfall barriers.

3. Design culvert installations to prevent erosion of fill. Compact the fill material to prevent seepage and failure. Armor the inlet and/or outlet with rock or other suitable material where needed.

4. Provide adequate drainage for the road surface. Use outsloped roads, insloped roads with ditches and crossdrains, or drain dips. Dips should be constructed deep enough into the subgrade that traffic will not obliterate them.

5. Plan ditch gradients steep enough, generally greater than 2%, but less than 8%, to prevent sediment deposition and ditch erosion. Gradient depends on parent material.

6. Design the spacing of road drainage facilities based on geologic type, soil erosion class, and road grade.

7. Where possible, install ditch relief culverts at the gradient of the original ground slope; otherwise anchor downspouts to carry water safely across the fill slope.

8. Skew relief culverts 20-30 degrees toward the inflow from the ditch to provide better inlet efficiency.

9. Provide energy dissipators where necessary at the downstream end of ditch relief culverts to reduce the erosion energy of the emerging water.

10. Protect the upstream end of crossdrain culverts from plugging with sediment and debris. Prevent downslope movement of sediment by using sediment catch basins, drop inlets, changes in road grade, headwalls, and recessed cut slopes.
11. Install culverts to assure protection from crushing due to traffic. Use 1 foot minimum cover for CMP's 15-36 inches in diameter, and a cover of 1/3 diameter for larger CMP's.

12. Use CMPs with a minimum diameter of 15 inches to avoid plugging.

13. Install road drainage facilities above stream crossings so water may be routed through a SMZ before entering a stream.

Road Construction

1. Place debris, overburden, and other waste materials associated with construction activities in a location to avoid entry into streams.

2. Minimize stream channel disturbances and related sediment problems during construction of roads and installation of stream crossing structures. Do not place easily eroded material into live streams. Remove material stockpiled on a floodplain before rising water reaches the stockpile. Locate bypass roads to have minimal disturbance on the stream course. Limit construction activity to specific times to protect beneficial water uses.

3. Minimize earth moving activities when soils appear excessively wet. Do not disturb roadside vegetation more than necessary to maintain slope stability and serve traffic needs.

4. Clear all vegetative material before constructing the fill portion of the road prism.

5. On potentially erodible fill slopes, windrow slash at the toe of the fill slopes to trap sediment, particularly near stream crossings and on erodible fill slopes.

6. Stabilize erodible, exposed soils by seeding, compacting, riprapping, benching, mulching, or other suitable means prior to fall or spring runoff.

7. Keep slope stabilization, erosion, and sediment control work as current as possible with road construction.

8. Install drainage structures concurrent with construction of new roads and always prior to fall or spring runoff.

9. Complete or stabilize road sections within the same operating season as construction is started, rather than leave major road sections in a pioneer condition over a winter season.

10. Minimize sediment production from borrow pits and gravel sources through proper location, development, and reclamation.

Road Maintenance

1. Grade road surfaces as often as necessary to maintain a stable running surface and to retain the original surface drainage.

2. Avoid cutting the toe of stable cut slopes when grading roads or pulling ditches.

3. When plowing snow for winter timber harvest, provide breaks in snow berm to allow road drainage.

4. Keep erosion control measures functional through periodic inspection and maintenance.

5. Haul all excess material removed by maintenance operations to safe disposal sites. Apply stabilization measures to these sites to prevent erosion. Avoid side casting material where it will enter a stream or be available to erode directly into a stream.

6. Leave closed roads in a condition that provides adequate drainage without further maintenance.

7. Restrict the use of roads during wet periods and spring breakup period if damage to road drainage features resulting in increased sedimentation is likely to occur.

Timber Harvest Design

1. Consider the following during development of timber harvest systems:

a) Soil characteristics and erosion hazard identification

b) Rainfall characteristics

c) Topography

d) Plant cover (forest type understory, silvics)

e) Critical components (aspect, water courses, landform, etc.)

f) Silvicultural objectives

g) Existing watershed condition

h) Potential effects of multiple resource management activities on beneficial water uses

i) Compliance with Montana Water Quality Act, State Water Quality Standards and Public Water Supply Act. Manage community and non-community public water supply watersheds to comply with State Water Quality Standards. The Public Water Supply Act (75-6-101-MCA) requires approval of plans and specifications for road and other disturbance from the Water Quality Bureau for activities planned for public water supply watersheds.

2. Leave streamside management zones (SMZs) (see definition) on both sides of perennial streams and intermittent streams with a well defined channel. This zone provides shading, soil stabilization, and sediment and water filtering effects.

3. Use the logging system that best fits the topography, soil type, and season, while minimizing soil disturbance and economically accomplishing silvicultural objectives. Consider the potential for erosion prior to tractor skidding on slopes greater than 40%.

4. Design and locate skid trails and skidding operations to minimize soil disturbance. The use of designated skid trails is one means of limiting site disturbance and soil compaction.

5. Locate skid trails to avoid concentrating runoff and provide breaks in grade.

6. Locate skid trails and landings away from natural drainage systems and divert runoff to stable areas.

7. Use the economically feasible yarding system which will minimize road densities.

Timber Harvesting Activities

1. Avoid falling trees or leaving slash in streams or water bodies.

2. Limb or top trees where debris cannot fall or be dragged into the stream.

3. Ground skidding through any perennial stream is not allowed except by permit from the Conservation District (Natural Streambed and Land Preservation Act of 1975 - 310 permit).

4. Minimize operation of wheeled or tracked equipment within the streamside management zone (SMZ) of stream courses designated for protection. Do not operate equipment on stream banks.

5. End-line logs out of streamside areas when ground skidding systems are employed.

6. Logs will be fully suspended when line skidding across a stream and immediately above streambanks.

7. Remove debris entering any stream concurrently with the yarding operation and before removal of equipment from the project site. Accomplish debris removal so the natural streambed conditions are not disturbed. Leave natural occurring downfall material providing fish habitat.

8. Avoid equipment operation in wetlands, bogs, and wet meadows except on designated roads. Use end-lining and directional falling for harvest operations in these areas.

9. Repair damage to a stream course caused by logging operations, including damage to banks and channel, to as reasonable condition as possible without causing additional damage to the stream channel.

10. Tractor skid when compaction, displacement, and erosion will be minimized.

11. Install necessary water bars in tractor skid trails prior to expected periods of heavy runoff. Appropriate spacing between bars is determined by the soil type and slope of the skid trail. Timely implementation is important.

12. Construct drainage structures on skid trails to prevent water and sediment from being channeled directly into stream course.

13. Construct water bars and/or seed skid trails and landings, where natural revegetation is inadequate to prevent accelerated erosion, before the next growing season. A light ground cover of slash or straw will help retard erosion.

14. Avoid skidding with the blade lowered.

15. Suspend the head end of the log whenever possible.

16. Minimize the size and number of landings to that necessary for safe, economical operation.

17. Avoid decking logs within the high water mark of any stream.

18. Provide suitable delivery, storage, and disposal for all fuels, shop debris, waste oil, etc.

Timber Slash Treatment and Site Preparation

1. Rapid reforestation of harvested areas is encouraged to reestablish protective vegetation.

2. Use brush blades on cats when piling slash. Avoid use of dozers with angle blades. Site preparation equipment producing irregular surfaces are preferred. Care should be taken to avoid severe disruption of the surface soil horizon.

3. Minimize or eliminate elongated exposure of soils up and down the slope during mechanical scarification.

4. Scarify the soil to the extent necessary to meet the reforestation objective of the site. Low slash and small brush should be left to slow surface runoff, return soil nutrients and provide shade for seedlings.

5. Carry out brush piling and scarification when soils are dry enough to minimize compaction and displacement.

6. Carry out scarification on steep slopes in a manner that minimizes erosion. Broadcast burning and/or herbicide application is a preferred means for site preparation on slopes greater than 40%.

7. Maintain an SMZ between site preparation or slash disposal areas and streams.

8. Scarify landings and temporary roads on completion of use.

9. Do not apply chemical vegetation control treatments to water bodies. Provide suitable buffer strips between chemical mixing and application areas and all water bodies.

10. Apply pesticide and dispose of containers according to label and EPA registration directions. Make contingency plans to follow in case of accidental spills. Mixing and disposal of chemicals should be supervised by a licensed applicator.

11. Limit water quality impacts of prescribed fire: construct water bars in firelines; reduce fuel loadings in drainage channels; maintain the streamside management zone; avoid intense fires unless needed to meet silvicultural goals.

Forest Fire Suppression

1. Minimize watershed damage from fire suppression by avoiding heavy equipment operation on fragile soils and steep slopes.

2. Stabilize suppression damage where erosion potential has increased. Treatments include installing water bars, seeding, planting, fertilizing, spreading slash or mulch on bare soil, repairing road drainage facilities, and clearing stream channels of debris.

3. Conduct burn area surveys where necessary to assess the need for rehabilitation of watershed damage. Rehabilitation measures may include: seeding, fertilizing, fencing, clearing debris from stream channels, constructing trash racks, channel stabilization structures and debris retention structures.

4. Consider the impacts of sewage disposal when establishing locations for fire camps, logging camps, or other similar facilities.

Construction Activities

1. Plan revegetation activities as a part of construction planning. Include contingency plans for poor revegetation periods (excessively wet or dry spells).

2. Plan developments around topography and soils to minimize soil impacts.

3. Where feasible, retain as much native vegetative as possible.

4. Reseed as quickly as possible and provide for temporary erosion control until revegetation is successful (mulching).

5. Minimize the area of disturbance.

6. Provide erosion control structures to prevent gulley formation, stream sedimentation and other adverse impacts.

7. Where significant erosion and sedimentation is likely, provide for sediment capture with mulching, temporary or permanent sediment basins and other methods.

8. Make sure that erosion and sedimentation will not affect adjoining properties.

9. Do not place fill in floodplains or channels of drainageways and streams without approval from all regulatory agencies.

10. Avoid or minimize equipment use and other activities in drainageways and other areas of concentrated runoff. Do not cross perennial streams without obtaining a 310 permit (Montana Streambed and Banks Protection Act).

11. Leave a buffer strip of undisturbed riparian vegetation along all streams.

Range and Pasture Management

1. Stock pastures at rates which will leave adequate plant cover to prevent erosion.

2. Fence livestock away from streambanks.

3. Maintain a wide, healthy buffer strip of vegetation between grazed pastures and streams to filter runoff.

Cropland Management

1. Provide grassed waterways, drop structures and other erosion control methods where needed.

2. Maintain maximum vegetative cover possible by using cover crops, minimum tillage, residue management, conservation cropping systems and other methods where practical.

3. Farm on the contour where possible.

4. Manage irrigation water to prevent erosion.

5. Maintain a wide, buffer strip of diverse vegetation between cropped fields and streams.

6. Where erosion is likely, provide sediment retention methods (sediment traps and basins).

APPENDIX 5. ADDITIONAL WATER QUALITY DATA FROM THE 1977 MORRISON AND MAIERLE STUDY)

TABLE 4-1

ASHLEY CREEK (values in mg/l)

Station		Temp.	TSS	NO_3	TP	COD	DO	F.C.	Alk.	S.C.	Ca	Na	Cl	K
1.	Avg.	14.3	.58	<1	.018	10.9	8.85	51	120	228	11.3	1.6	<2	1.83
	High	19	1.5	<1	.04	17.6	10.2	248	131	240	19	6	<2	9
	Low	10*	0	<1	<0.01	5.8	7.8	7	105	190	4	2	<2	2
2.	Avg.	10.5	1.47	1	.034	17.0	9.8	52	144	266	13.2	1.8	.57	1.28
	High	15.5	5	1	0.10	43.9	11.6	150	156	280	16	7	2	4
	Low	4	0	1	.01	5.8	9.2	10	136	260	2	<2	2	2
3.	Avg	11.7	1.14	1	.058	13.77	8.7	78	117	204	16.2	2.1	.57	1.20
	High	17	10	1	.09	23.3	11.0	180	140	270	14	7	2	5
	Low	4	0	1	.01	2.0	5.3	25	98	140	5	<2	2	2
4.	Avg.	13.2	5.5	1	.072	28.4	7.04	219	109	210	11.4	2.5	.85	1.28
	High	19	15	1	.18	34.9	10.8	800	141	280	14	7	2	3
	Low	6.5	0	1	.02	17.6	5.9	14	93	160	2	<2	2	2
5	Avg	12.5	7.14	1	.052	20.88	9.5	66	131	249	13.1	3.2	1.57	1.57
	High	18	17	1	.11	31.6	11.4	160	161	290	14	11	3	3
	Low	7	0	<1	.02	5.9	8.2	10	107	170	3	<2	<2	2
6.	Avg.	13.3	13.8	1.5	.046	21.6	9.5	170	140	306	13.2	3.8	2.14	2.42
	High	18	37	2	.06	58.7	11.2	300	188	360	34	11	4	4
	Low	8	6	1	.02	5.9	8.4	27	125	200	4	2	2	2
7.	Avg	14	21.1	3.25	0.558	20.7	7.4	2,401	163	127	18.8	4.8	8.42	3.28
	High	20	57	8	.81	31.0	10.0	12,700	186	410	32	10	15	8
	Low	8.5	2	1	.26	9.8	5.3	76	129	180	9	<2	2	2
8	Avg.	14.1	14.8	[illegible]	0.758	20.6	6.74	2,254	172	170	19	7.28	13.1	3.5
	High	20	43	12	1.04	33.0	12.1	12,200	196	440	32	19	73	7
	Low	9	5	3	.25	9.8	3.0	14	112	220	11	2	4	7

* Could not sample 4/28/76

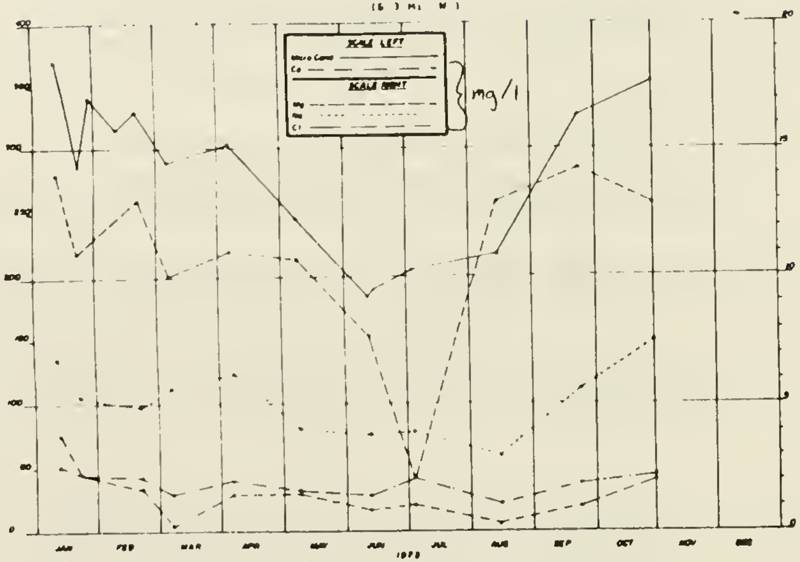
ASHLEY CREEK PHENOL SAMPLING

In order to further evaluate the extent of phenol pollution in Ashley Creek as it passes through Kalispell, four additional sampling stations were established (Figure A). These stations represent sampling locations that the FD 208 Agency Staff felt would help isolate the increase in phenol identified in the initial sampling. Samples were collected by the FD 208 Agency and phenol analysis was performed by the State of Montana (Dept. of Health and Environmental Sciences). The following results were obtained:

PHENOL ANALYSIS

Station Location		Concentration (ug/liter)
No. 1	West of Town	>1
No. 2	Ashley Creek	5
No. 3	Spring Creek Tributary	3
No. 4	Collapsed Bridge	6

This data verifies the previous analysis that showed the phenol concentration increases near Kalispell above that normally indicated for a satisfactory freshwater environment (1-ug/l).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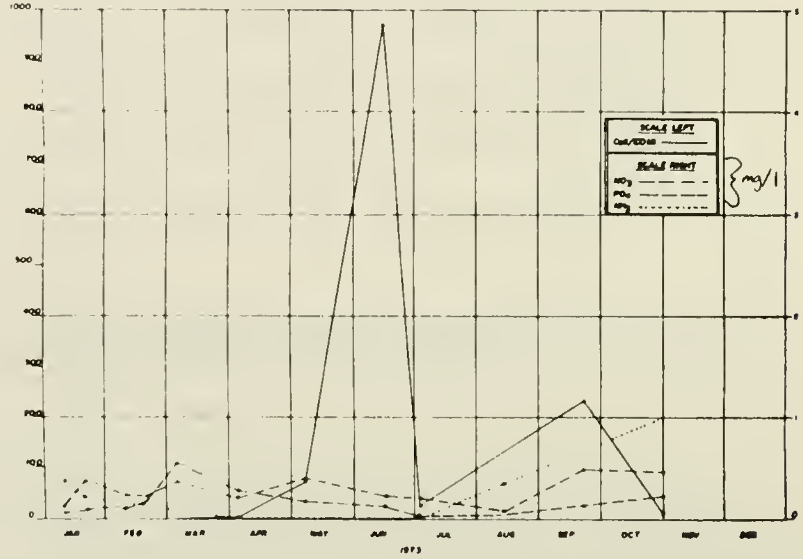
(6.3 MI. W.)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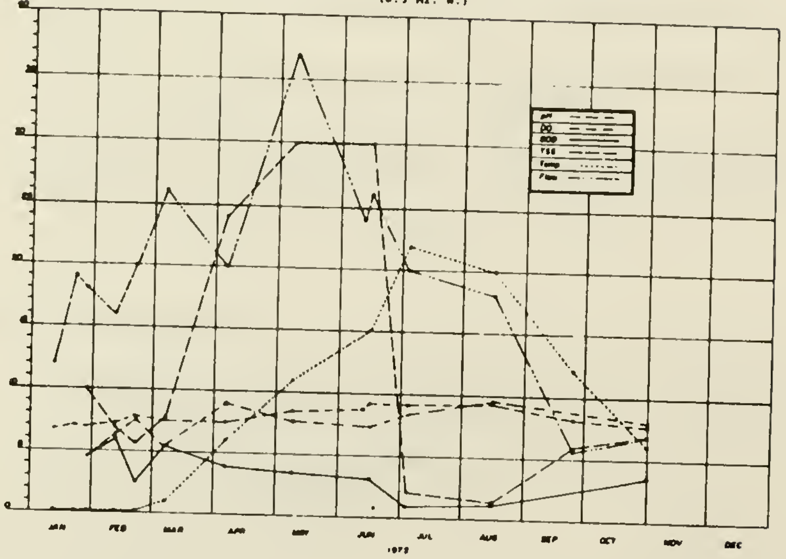
(6.3 MI. W.)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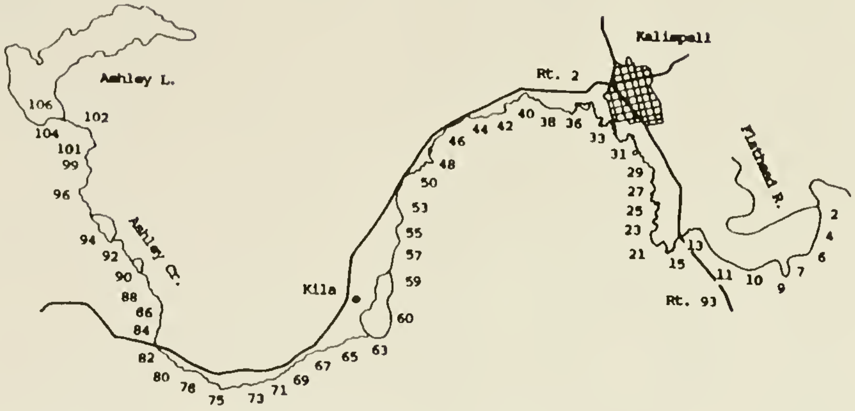
(6.3 MI. W.)

APPENDIX 6: STREAM INVENTORY PHOTO INDEX



APPENDIX 7: EXAMPLES OF PLANT SPECIES FOR STREAMBANK REVEGETATION ALONG ASHLEY CREEK (see your conservation district for additional information)

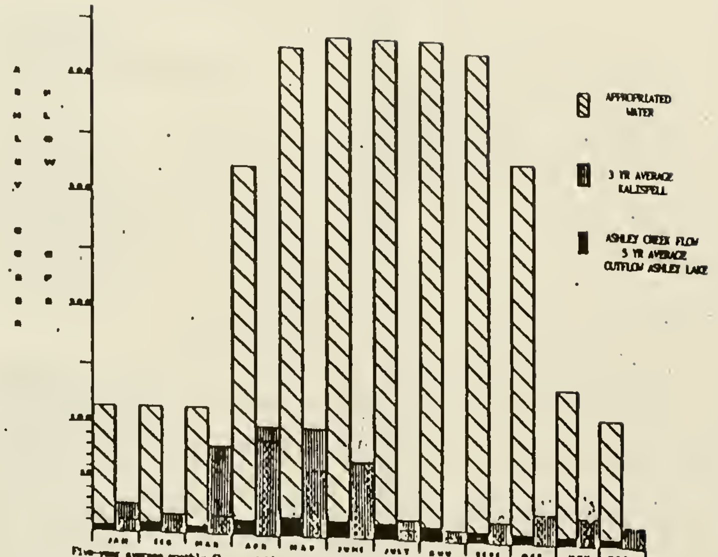
TREES	Mature Height (ft)
Black cottonwood	60-90
Robusta cottonwood	40-60
Aspen	40-60
Paper birch	40-60
Golden willow	30-40
White willow	30-40
American elm	40-60
Green Ash	25-35
Engelmann spruce	60-100
Colorado blue spruce	50-100
Douglas-fir	50-100
Lodgepole pine	60-90
Ponderosa pine	80-100
SHRUBS	
Bebb's willow	5-10
Drummond's willow	5-10
Geyer's willow	5-10
Blueberry willow	4-8
Scouler's willow	5-15
Purple willow	6-10
Buffalo berry	8-12
Honeysuckle	8-12
Lilac	8-12
Wild rose	4-10
Chokecherry	10-15
Redstem dogwood	8-12
American plum	10-15
Caragana	10-15

APPENDIX 8. ADDITIONAL STREAMFLOW INFORMATION (Provided by Gary Anderson, Montana Department of Fish, Wildlife and Parks)

ASHLEY LAKE FLOW RELEASES AT LAKE OUTLET

1981-1987 - Average Daily Flow by Month

Month	1981	1982	1983	1984	1985	1986	1987	7 Year Average
January	--	10.6	7.0	8.0	8.0	6.0	10.0	8.3
February	--	14.1	9.3	4.5	7.5	6.0	7.0	13.0
March	--	10.6	9.2	5.2	7.0	5.8	5.0	7.1
April	--	13.6	11.0	5.0	7.0	26.7	4.0	11.2
May	--	24.2	20.5	5.8	8.0	32.0	4.0	15.8
June	--	31.5	11.9	11.0	7.0	15.5	10.2	14.5
July	--	22.6	6.6	19.1	10.0	12.4	17.0	14.6
August	9.6	12.4	7.0	18.8	15.0	13.3	14.7	13.0
September	12.1	12.1	7.2	10.2	8.5	12.7	13.2	8.8
October	13.7	9.7	8.9	9.3	8.0	13.2	7.5	10.0
November	14.1	9.3	8.7	9.5	8.0	11.0	6.0	9.5
December	11.6	8.9	7.3	8.5	7.5	10.0	6.0	8.5
Avg.Daily Flow	9.8	14.6	9.4	9.6	8.5	13.7	8.8	11.2
Acre Ft. Released	7,091	10,613	6,787	6,934	6,126	9,931	6,329	7,687



Five-year average monthly flow on Ashley Creek at the outlet below Ashley Lake 1982 through 1986, total monthly appropriated water through 1985, and 3 year average monthly flow 1984 through 1986 at culvert near the end of south Meridian Road in Kalispell. Measurements in cubic feet per second (cfs).

********************* WATER FACTS ********************

1 Gallon = 8.3 pounds

1 Cubic Foot = 7.48 gallons = 62.4 pounds

1 Acre Foot = Amount of water needed to cover 1 acre 1 foot deep

= 43,560 cubic feet

= 325,900 gallons

= 1 year's water supply for a family of five

1 - 2 Acre Feet = per acre irrigation requirement in Montana

1 Cubic Foot per Second (cfs) = Discharge from a flume 1 foot wide by 1 foot high flowing at 1 foot per second

1 cfs will support an average 80 acres of sprinkler irrigation

1 cfs will cover 1 acre 1 inch deep in 1 hour

1 cfs = 40 miners inches

Montana miners inch = discharge through an orifice 1 inch square under a specified head

= approximately 40 gallons/minute

Humans require 2 - 3 quarts of water per day

Cattle require 10 - 12 gallons of water per day

The average per capita residential water use is 100 - 300 gallons of water per day